The Effect of Financial Innovation on Economic Growth in African Countries

A Dissertation

presented to

The **Development Finance Centre (DEFIC)**

The Graduate School of Business

University of Cape Town

In partial fulfilment

of the requirements for the Degree of

Master of Commerce in Development Finance

by

Kirsten Amsterdam

(AMSKIR001)

February 2018

Supervisor: **Abdul Latif Alhassan, Ph.D.**

PLAGIARISM DECLARATION

Declaration

1. I know that plagiarism is wrong. Plagiarism is to use another's work and pretend that it is one's own.
2. I have used the American Psychological Association (APA) 6th Edition convention for citation and referencing. Each contribution to, and quotation in, this dissertation from the work(s) of other people has been attributed and has been cited and referenced.
3. This dissertation is my own work.
4. I have not allowed, and will not allow, anyone to copy my work with the intention of passing it off as his or her own work.
5. I acknowledge that copying someone else's assignment or essay, or part of it, is wrong, and declare that this is my own work.

Signed by candidate

Kirsten Amsterdam

ABSTRACT

This study investigates the relationship between financial innovation and economic growth in twenty-five countries in Africa. The relationship is estimated in a panel of countries, utilising Fixed and Random Effects Testing, and compared with the results when the same relationship is tested between individual African countries using the Ordinary Least Squares (OLS) method. Three proxies for financial innovation the growth in bank credit to the private sector, the ratio of broad money to narrow money and mobile penetration and data for four financial innovations automated teller machines, mobile money accounts and mobile money agents and mobile transactions are used in the estimations.

The results indicate that measures which have a significant effect on growth and non-mobile related proxy measures, are generally negative. The mobile financial innovations generally have a positive effect, particularly in countries with low levels of financial development. This study firstly concludes that mobile linked financial innovation has a positive effect on growth in Africa, therefore policy and regulation should be geared towards encouraging further positive impact. Secondly, this study concludes that the level of financial development in African countries impacts the extent and the manner in which financial innovation impacts growth.

It is recommended that the focus on improving financial inclusion, utilising financial innovation, particularly mobile financial innovation should be continued, in order to improve financial depth and efficient allocation of resources and financial intermediation. Further research is also required into the effects of financial innovation specific to individual countries, and the nuances between them, as well as the role of regulation and financial development on financial innovations effect on growth.

TABLE OF CONTENTS

PLAGIARISM DECLARATION i

ABSTRACT ii

TABLE OF CONTENTS iii

LIST OF FIGURES AND TABLES v

GLOSSARY OF TERMS vi

ABBREVIATIONS vii

ACKNOWLEDGEMENTS viii

CHAPTER 1: INTRODUCTION 1

1.1 Background of the Study 1

1.2 Problem Statement 2

1.3 Purpose and Significance of the Research 3

1.4 Research Questions and Scope 4

1.5 Organisation of the Study 5

CHAPTER 2: LITERATURE REVIEW 6

2.1 Introduction 6

2.2 Definition of Financial Innovation 6

2.3 Theoretical Review: Financial Innovation and Economic Development 9

2.4 Financial Innovation in Africa Review 15

2.4.1 The Role of Banks in Financial Innovation in Africa 19

2.4.2 The Role of Policy and Regulation in Financial Innovation in Africa 19

2.4.3 The Role of ICT in Financial Innovation in Africa 23

2.4.4 From the Majority of Africa Being Unbanked to More Financial Transactions with Financial Innovation 24

2.4.5 Current Financial Innovation in Africa 28

2.5 Empirical Review: Financial Innovation and Economic Growth 37

CHAPTER 3: RESEARCH METHODOLOGY 44

3.1 Introduction 44
3.2 Data and Sources 44
3.3 Model Specification 45
3.4 Definition and Measurement of Variables 48
3.5 Estimation Approach 51
CHAPTER 4: DISCUSSION OF FINDINGS 53
4.1 Introduction 53
4.2 Descriptive Statistics 53
4.3 Correlation Analysis 54
4.4 Regression Results 55
4.4.1 Country-level estimations 60
4.4.2 Financial Innovations and Economic Growth: The Role of Financial Development 65
CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS 71
5.1 Introduction 71
5.2 Summary of Study and Conclusions 71
5.3 Policy Recommendations 73
5.4 Avenues for Future Research 75
REFERENCES 77
APPENDICES 84

LIST OF FIGURES AND TABLES

List of Figures

Figure 1: Real GDP Growth across African Regions (2016) 17

Figure 2: Real GDP Growth (%) across African Regions (2008 - 2018) 18

Figure 3: Adoption of Mobile Money Services in Africa, by region: Registered accounts 18

Figure 4: African Countries with Mobile Money by Regulatory Approach (Dec 2014) 29

Figure 5: Number African Countries with Mobile Money by Regulatory Approach (Dec 2015) 22

Figure 6: Mobile Cellular vs Fixed Telephone Subscriptions Penetration (per 100 people) ... 23

Figure 7: Physical Access Points for Financial Services in Sub-Saharan Africa 25

Figure 8: Spread of Live Mobile Money Services by Region (2001-2016) 26

Figure 9: Growth of registered Mobile Money Accounts in Sub-Saharan Africa 26

List of Tables

Table 1: Analysis Countries, Region and Income Level Classification 44

Table 2: Variables Description and Source 49

Table 3: Descriptive Statistics 53

Table 4: Correlation Analysis 55

Table 5: Random Effects, Fixed Effects and Hausman Test Results 58

Table 6: Individual African Countries Results 62

Table 7: Individual African Countries Results (Mobile Penetration) 63

Table 8: Analysis Countries, Region, Regulatory Environment and Financial Development Classification 64

Table 9: Financial Development Analysis (Top Ranked Countries) 66

Table 10: Financial Development Analysis (Bottom Ranked Countries) 67

GLOSSARY OF TERMS

Fintech:	Computer programs and other technology used to support or enable banking and financial services.
M1:	A metric for the money supply of a country and includes physical money, chequing accounts, demand deposits and negotiable order of withdrawal (NOW) accounts.
M2:	A measure of the money supply that includes all elements of M1 as well as "near money" (saving deposits, money market securities, mutual funds and other time deposits).
M-Pesa:	A mobile phone-based money transfer, financing and microfinancing service.
Safaricom:	A leading communications company in Kenya and founder of M-Pesa.
Shwari:	A paperless banking service offered through M-Pesa.
Susu:	An informal means of collecting and saving money through a savings club or partnership.
Euromarket:	A market that includes the European Union member countries.
Sharia Investment Products:	Investments which are in accordance with Islamic Principles.

ABBREVIATIONS

ATM:	Automated Teller Machine
AFI:	Alliance for Financial Inclusion
CBA:	Commercial Bank of Africa
CBK:	Central Bank of Kenya
CEO:	Chief Executive Officer
CFA:	Communauté financière d'Afrique (Financial Community of Africa)
FNB:	First National Bank
GDP:	Gross Domestic Product
GMM:	Generalised Method of Moment
GSMA:	Groupe Spéciale Mobile Association
ICT:	Information and Communication Technology
IMF:	International Monetary Fund
KEPSS:	Kenya Electronic Payment and Settlement System
KShs:	Kenyan Shilling
MNO:	Mobile Network Operators
OECD:	Organisation for Economic Co-operation and Development
POS:	Point of Sale
RTGS:	Real Time Gross Settlements
SADC:	Southern African Development Community
SARB:	South African Reserve Bank
SMS:	Short Messaging Services
TFP:	Total Factor Productivity

ACKNOWLEDGEMENTS

The work in this dissertation would not have been possible without the help and support from many people. I'd like to take this opportunity to extend my gratitude and my appreciation to all those who made this dissertation possible.

I would like to extend my sincere gratitude to my supervisor Dr Latif Alhassan for his guidance, humour and advice throughout the process.

Thank you to my friends for always lending an ear and for their constant motivation.

To my partner, thank you for your unfailing patience, understanding, support, encouragement and confidence in me.

To my parents, thank you for being my biggest cheerleaders, inspiration and believing in me throughout my master's journey.

CHAPTER 1:

INTRODUCTION

1.1 Background of the Study

Economist, Joseph Stiglitz in a description of financial markets said, "I see the market as a powerful instrument for doing good - but one which has not only lived up to its potential, but has in the process, left some behind, and actually some worse off" (Institute of Development Studies, 2010). His description depicts the reality for most of the African countries, where financial systems are underdeveloped and are not suited to the large demographic groups in the relevant countries.

The structure of current financial systems and markets is not conducive to optimally cater to individual and unique needs (Institute of Development Studies, 2010). Due to this, the maximum amount of individual's are not able access markets, with regulations, as well as a lack of infrastructure in many countries, maintaining the current status quo in many African countries where financial needs are not met.

Mark Napier, previous Chief Executive Officer (CEO) of FinMark Trust in South Africa also argued this, stating that there was room for traditional financial services to be more inclusive, and to offer a service that is feasible and practical for those at the "bottom of the pyramid". He rejected the notion of microfinance organisations being the only service providers for these individuals; stating that, "The key is the right product in the right place at the right time" (Institute of Development Studies, 2010). Innovation in financial services grants access to the market that was not possible previously, within conventional products, services and infrastructure.

Financial innovation has an important role to play in solving Africa's challenges (Beck, Senbet, & Simbanegavi, 2015); taking into account the existing social, political and cultural realities and norms of African countries. In doing, so financial innovation is able to overcome high risk conundrums in these contexts, while simultaneously addressing the issue of high levels of unbanked individuals in Africa. This will also facilitate growth at both a micro and macro level, and will allow the two to complement each other towards sustained growth and greater economic competence (Agoba, Bugri-Anarfo, & Sare, 2017), in order to compete with the rest of the globe. Financial innovation can also address the second hurdle, being high risk. Financial

innovation is more likely to be closer to individuals in communities not familiar with financial products and services. Trust is then easier to build, reducing the perceived risks of potential customers and making it crucial in reducing the number of unbanked individuals on the continent (Beck et al., 2015).

Transforming weak and non-existent markets in Africa, using technology as a key driver to fix old problems will be essential for many reasons. As stated, it will disrupt the traditional banking sector, forcing the sector to increase access to financial markets for individuals and small businesses at the lower end of economies (World Economic Forum, 2016). In addition, it will enable government efficiency and growth in new sectors (World Economic Forum, 2016).

Whether focusing on new financial instruments, financial institutions, or financial reporting techniques, successful technological innovations have often required the invention of new financial arrangements (Michalopoulos, Laeven, & Levine, 2009). Therefore, there is a unique role for government to play in enabling the progress of financial development.

Innovation in the financial markets is important for achieving a socioeconomic blueprint in Africa (Adjasi, 2015) and recent innovations have been integral in driving this inclusive economic growth, by helping individuals and entrepreneurs to gain access to finance to either start up or scale their businesses (World Economic Forum, 2016). Financial innovation in Africa, and its contribution to financial systems and economic competence is acknowledged on the continent, however little empirical evidence of this, in literature, has been shown to date (Bara, Mugano, & Roux, 2016; Mwinzi, 2014). The causality and the extent to which the current financial innovations have had an impact on growth rates in developing countries have also not been specified (Levine, 1997).

1.2 Problem Statement

In the African context, very little empirical research has been done on the nature of the relationship between financial innovation and economic growth, or on the causality or the extent to which growth rates in developing countries are driven by financial innovation. Similarly, Levine (2007) notes that it has not been specified in research conducted in developed countries. The research that has been done in Africa has centred on welfare issues in relation to financial inclusion (Chibba, 2009). For example, it is widely known and accepted that the impact of innovation on the banking services sector has been immense and is noteworthy. However, the extent to which these innovations have affected the economy, either positively

or negatively, is unknown with the relationship not having been tested in African countries (Bara & Mudzingiri, 2016). Research work on economic growth in African countries has focused mainly on the importance of natural resources, agriculture and commodities in positive growth, together with improved macroeconomic management seen in these countries (Mlachila, Park, & Yabara, 2013).

A stumbling block to assessing the relationship between financial innovation and economic growth, is the vast diversity of economies across the continent, with varying levels of financial development, economic structures and growth (Allen, Otchere, & Senbet, 2011). Therefore, an assessment is needed that will take these variances into account and will determine whether financial innovation's effect on economic growth also varies across regions and economic and financial structures. A comprehensive picture of the overall state of financial innovation in African countries does not currently exist (Chibba, 2009), and therefore the nuances and any potential differences in the effect of financial innovation has had on various economies has not been evaluated (Bara et al., 2016).

While the positives of financial innovation in Africa have been noted and praised, it is also important to note that financial innovation has a dark side. Literature argues for the existence of both positive and negative elements of financial innovation. However, where research has been conducted regarding the bright and dark sides of financial innovation, it has largely focused on the negative effects of financial innovation seen in developed countries. The 2007/8 financial crisis is an example of the dark side of innovation in established economies. Academic literature and industry experts alike, have attributed the 2007/8 financial crisis to financial innovation, especially in the developed world (Allen et al., 2011; Llewellyn, 2009) with some calling it a tool of economic destruction (Bara & Mudzingiri, 2016).

Little to no research has been conducted on the potential dark side of financial innovation in African or emerging market economies. Where there are uncertainties, there is a gap for clarity to be provided. Therefore, research into mechanisms to maximise the positive elements needs to be done, as well as ascertaining where the bad elements need to be minimised.

1.3 Purpose and Significance of the Research

Understanding the determinants of economic growth on the continent is imperative for financial institutions and policy makers to acknowledge unsuitable financial systems, and to innovate, rethink and redesign innovative interventions and structures that are unique to a

country's social economic structure. This could allow for innovations that will encourage maximum economic growth.

This research will fill the current knowledge gap in literature, by providing empirical evidence on the nature of the relationship between financial innovation and economic growth in African countries. It will take into account the diversity across the countries in question (Adu, Marbuah, & Mensah, 2013), particularly the varying levels of financial development and regulation .

In doing this, the research paper will provide guidance to law and policy makers, on how best to encourage and support financial innovation in African countries, towards achieving higher levels of sustained economic growth.

The general assumption is that the increased usage of innovative financial products and services will increase economic activity and in turn will increase economic growth.

Once these relationships are known, policymakers, lawmakers, economists, innovators, firms and individuals will have more guidance when deciphering which areas to focus on towards increasing and improving financial innovation. It will assist governments and policy makers to create an enabling environment for financial innovation; as well as assisting economists to build better models and systems for financial innovation and economic growth in African countries and finally, it will assist development finance institutions and financiers with deciding where to invest their time and their money.

1.4 Research Questions and Scope

Therefore, the following research questions and their associated hypothesis arise:

a) What is the nature of the relationship between financial innovation and economic growth in African countries?

b) How does the level of financial development in African countries impact economic growth through the financial innovation channel?

c) How should financial systems be redesigned or restructured, by financial institutions, the law, and policy makers to allow for maximum economic growth and development in African countries?

This study hypothesises that the relationship between financial innovation and economic growth is positive in developing countries in Africa. It also hypothesises that the causality between financial innovation and economic development will differ from one region to the next, as well as between countries within a region, based on unique determinants, including the level of financial system development and regulation.

It is proposed that the current financial and regulatory systems in place could be improved to allow systems to be more conducive to financial innovation in many countries.

Finally, the empirical results of this study should give additional guidance to financial system modifications, policy recommendations and further research to be conducted.

The objectives of this study will be four-fold namely,

a) To examine the relationship between financial innovation and economic growth in African countries;

b) To examine the cross-country differences in the relationship between financial innovation and growth in African countries; and

c) To assess the effect of financial development on the relationship between financial innovation and economic growth.

1.5 Organisation of the Study

Following this introductory chapter, outlining the current state of financial innovation across Africa, the importance of such innovation to the positive development of the continent and the current knowledge gap, regarding the relationship between financial innovation and economic development will be shown. This text will be structured as follows: Chapter 2 will present a review of existing literature on the topic and Chapter 3 will present the methodology and procedures used for data collection and analysis, as well as justification and limitations for the data used. Chapter 4 will contain an analysis of the data and presentation of the results. Finally, Chapter 5 will provide a discussion of the findings and implications for practice and policy, including recommendations for future research.

CHAPTER 2:

LITERATURE REVIEW

"The centrality of finance in an economy and its importance for economic growth naturally raises the importance of financial innovation" (Levine, 1997).

2.1 Introduction

This chapter will provide a background to financial innovation from both a theoretical point of view, as well as a practical perspective, with specific focus given to innovations on the African continent. The evolution of the definition and concept of financial innovation over time, will be discussed. In the theoretical review, the relationship between financial innovation and economic growth, the way financial innovation contributes to economic growth and existing models of the abovementioned relationship; will be discussed and analysed.

From a practical perspective, economic growth rates in Africa will be discussed. Context will also be provided on the current extent of financial innovation on the continent and the roles that traditional banks, policies, regulations and information and communication technology have played in the rise of financial innovation on the continent, will also be considered. The subsequent contribution of financial innovation to decreasing the number of unbanked individuals on the continent will also be considered. The final subsection of the literature review chapter will provide an overview of existing research conducted on the topic and will highlight the gaps in the research, particularly research pertaining to African countries.

2.2 Definition of Financial Innovation

Financial innovation has been researched over a number of years, without a standard definition of the phenomenon being agreed upon. Schumpeter (1911) argues for the idea of development as a process of structural changes driven by innovation, stating that the services provided by financial institutions are imperative for both technological innovation and economic development. This makes him one of the first economists to argue for the relationship between finance, innovation and growth. Furthermore, he describes the services offered by financial institutions, particularly the mobilisation of savings, evaluation of projects, managing risk and managers, as important for both technological innovation, as well as economic development (Schumpeter, 1911; Schumpeter & Opie, 1934).

Schumpeter also views innovation in a macro sense, as the creation of new economic systems that will replace and make obsolete the old economic systems almost as soon as they are produced. He describes the process by which both entrepreneurs and organisations utilise innovation as a source of profit in economic systems, which over time, would lead to a more efficient economic system. The disturbance created by innovation could be attributed to competition, either from a new technology, product, commodity, supply or organisation, providing a cost or quality advantage to the entrepreneur or organisation in question (Mwinzi, 2014). According to Schumpeter, innovation is integral in the explanation of economic growth (Schumpeter, 1911; Schumpeter & Opie, 1934). He refers to the process, calling it "creative destruction" (Schumpeter & Opie, 1934).

The later work by Gurley and Shaw (1995), Goldsmith (1969), McKinnon (1973) and Shaw (1973) supported the writings of Schumpeter (1911) and Schumpeter and Opie (1934). Goldsmith and McKinnon also illustrated the role of finance in growth empirically, as did the more recent research of King and Levine (1993), with the latter expanding Schumpeter's theories, by including the role of both entrepreneurs and organisations.

In a lecture delivered at the ISBI Workshop on Institutional Reforms for African Savings Banks, Arnoldo Mauri (1983) defines innovation as the "driving force behind financial development, which is the prerequisite to economic growth" (Mauri, 1983). He defined financial innovation as "qualitative change that has a decisive impact on the structure and on the performance of the financial system, that may also exert a significant influence on the real sector of the economy" (Mauri, 1983). Similarly, the work of King and Levine (1993) illustrated the role of the financial systems towards achieving economic growth. Therefore, Mauri (1983) and King and Levine (1993) illustrated that Schumpeter had been right in his theories regarding innovation and financial systems, arguing for the role of innovation in achieving economic growth.

Michalopoulos, Laeven and Levine (2009) expanded Schumpeter's seminal work by building a "Schumpeter endogenous growth model" and finding a positive correlation between technological and financial innovation. The research did assert that the relationship would stagnate at some point, if financiers failed to innovate (Chikezie, Chijindu, & Okafor, 2017; Michalopoulos *et al.,* 2009). The introduction of the new financial innovations evolve with technology over time (Michalopoulos *et al.,* 2009), and in many cases in a synergistic manner.

In defining financial innovation, Michalopoulos, Laeven and Levine (2009) viewed financial innovation as the development of new financial instruments, the creation of new corporate structures or financial institutions and accounting or reporting techniques. Similarly, according to Beck et al., (2015), financial innovation includes new products, organisation forms and financial processes, who are able to assist in the reduction of transaction costs and assist in the provision of risk management tools and information asymmetry. Tufano (2003) adds new markets, research and development, and finally, the need to be popularised, to the definition. Bara, Mugano, and Le Roux (2016) also argue for the inclusion of mundane financial improvements; for example, improvements in financial reporting procedures, data processing and credit scoring.

Financial innovation does not necessarily need to be a completely brand-new innovation. It is in fact very rare that any innovation is brand-new. They are more often a modification or adaptation of existing products or processes, to improve profitability for the innovating firm or financer, or in an effort to satisfy the needs or the wants of consumers (Utterback & Afuah, 1998). Utilising the above definition, financial innovation should offer a new product or service to customers, without increasing costs to the customer, and should be an improvement on previous technologies and services (Utterback & Afuah, 1998).

These definitions, focus mainly on western literature's view of the definition of financial innovation, with the exclusion of Bara, Mugano, and Le Roux (2016). For the purposes of this study, defining financial innovation in the African context is imperative.

Financial innovations in Africa, according to Beck et al., (2015) can be differentiated from the existing definitions, particularly by including mobile banking or specifically access to basic banking services, utilising a mobile phone without the need for a bank account or a physical bank branch. Financial innovation in Africa also includes the ability to enable the automated screening of entrepreneurs with high potential, allowing the provision of insurance to the agricultural sector and the introduction of untraditional market players into the financial sector (Beck et al., 2015).

Keeping these definitions in mind, the relationship between financial innovation and the impact it has in economic growth and the way financial innovation practically translates to economic growth, is discussed further.

2.3 Theoretical Review: Financial Innovation and Economic Development

The mechanics through which financial innovation translates into economic growth is a debated topic. The role of financial innovation is not clear; however many seem to suggest that an increase in financial development ultimately leads to economic growth (Mwinzi, 2014). The seminal work by King and Levine (1993), initiated a multitude of empirical studies investigating the relationship between finance and growth. However, the causality between the two is not agreed upon.

Arguments have arisen, stating that the relationship between the two is not as strong as it used to be. Rousseau and Wachtel (2011) empirically illustrated that the strength between finance and growth is dwindling, utilising a similar dataset used by King and Levine in their ground-breaking study (Idun & Aboagye, 2014). Rousseau and Wachtel (2011) concluded that the strength of the relationship between finance and growth was declining, therefore supporting the views of (Robinson (1952) and Lucas (1988).

Robinson (1952) argues for a converse relationship between financial innovation and economic growth, saying that the role of finance is not as important in determining growth. She states that economic growth drives the demand for financial services, as opposed to the other way around. Finally, there are arguments by Lucas (1988) that a relationship between the two variables does not exist and that there is no possibility of the financial sector having an impact on growth. Lucas (1988) also argues that the role of finance in growth is overstated by economists, while Robinson (1952) argues that finance follows the leadership of enterprises. Robinson goes further, stating that economic development creates the demand for specific financial arrangements, which the financial system then responds, to while other economists do not believe that the relationship between finance and growth to be important at all (Levine, 1997).

Bilyk (2006) attributes the individual emergence of financial innovation to the desire to increase profits when providing goods and services. Lewis and Mizen (2000), Chikezie et al., (2017) and Utterback and Afuah (1998) attribute it to changes in the requirements of customers, and individual's desires, as well as supplier-related conditions, operating or financial conditions, environmental conditions, policy conditions and the availability of technology or the lack thereof.

Multiple authors (Beck et al., 2015; Merton, 1992; Mwinzi, 2014) believe that the reduction of transaction costs plays an important role in the prevalence of financial innovation. It also allows for the reduction of risk (Beck et al., 2015; Merton, 1992) and facilitates the consumption of goods and services through effective payment services (Arnaboldi & Rossignoli, 2013; Bara & Mudzingiri, 2016; Merton, 1992), the extraction of information for the support of decision making, addressing moral hazards (Idun & Aboagye, 2014; Merton, 1992) and asymmetric information (Beck et al., 2015; Merton, 1992).

This collective efficiency brings about the reduction of costs, improvement of payment services and a reduction in information asymmetry, as indicated by Agoba, Bugri-Anarfo, and Sare (2017) and Utterback and Afuah (1998) and plays a role in the rise of financial innovation. Merton (1992) stated that financial innovation is driven by parties with the intent of increasing both market efficiency and social welfare (Mwinzi, 2014). He goes on to provide three motivations arguing for the role of efficiency in financial innovation; namely, the improvement of efficiency by increased risk allocation and sharing, the creation of new structures allowing for the sharing of resources and, finally, improved economic efficiency, liquidity and reduction in agency costs (Mwinzi, 2014). This therefore assists in the main functions of the financial system, through various payment systems, savings mobilisation and transfer of funds from net savers to investors of funds, as argued by Chikezie, Chijindu and Okafor (2017), Mishra (2007) and Beck et al., (2015).

In terms of the relationship between financial development, innovation and economic growth, two main schools of thought exist. The optimistic view was most popular between 1990 and the 2000s, with the sceptical view gaining popularity post 2000. The optimists, King and Levine, (1993), Rajan and Zingales (1998) and Levine, Loayza, and Beck (2000) rationalised the role of financial innovation and financial development, as having a role to play in achieving economic prosperity and sustained growth. Michalopoulos et al., (2009) and Beddoes (2010) argued further that financial innovation is imperative for sustaining economic growth, and that the most recent decades are a testament to this. Levine (1997) echoes these sentiments, arguing that financial and technical development are linked, suggesting that the former is crucial for improving the wealth of nations. Mishra (2007) looked at financial innovation overall, stating that the introduction of financial technologies improves the productivity of capital and decreases transaction costs, thereby increasing economic growth.

The works of the abovementioned authors, showed the positive influence that financial innovation has on a country's economy. The beliefs were popular during a time of rapid increases in the offerings of financial services and liberalisation, seen in economies globally (Ductor & Grechyna, 2015). The optimists argued that financial systems mobilize savings and facilitate the efficient allocation of resources (Ductor & Grechyna, 2015), resulting in the reduction of agency costs and improved innovation activities (Aghion, Howitt, & Mayer-Foulkes, 2005); contributing to high-return investments through risk-sharing (Ductor & Grechyna, 2015).

After 2000, the sceptics who highlighted the negatives of financial innovation became more popular, particularly because of the financial crises of 1997/98 and 2007/08. They argued that financial development led to high systemic risks, suboptimal low savings and overcompensation of economic capacity, or inefficient, high costs for the economy (Ductor & Grechyna, 2015).

The views of the optimistic and sceptics authors, contributed further to the arguments, stating that innovation is often seen as a double-edged sword (Arnaboldi & Rossignoli, 2013). The "bright side" saw innovation as a contributing factor to economic growth, through the improvement of banking services, enabling risk sharing, more competitive markets, improving allocation of funds and encouraging investments in new technologies that assisted the financial system, in fulfilling its intermediary role (Bara et al., 2016b; Beck, Chen, Lin, & Song, 2016).

The literature also highlighted the dark side of financial innovation, most notably attributing the 2007/08 financial crisis to risky financial innovation. Beck, Chen, Lin, and Song (2016) stated that too much or inefficient innovation can have serious consequences for the overall economy. Beddoes (2010) also contributed to this argument, despite advocating for financial innovation's contribution to economic growth in recent decades. He states that the last few centuries are evidence that financial innovation can be used as a tool for economic destruction.

Both Allen (2012) and Llewellyn (2009) argued that the 2007/08 global financial crisis was created through financial innovations, which were originally seen as safe but were in fact high-risk (Bara et al., 2016). Allen (2012) argued further that the securitisation and sub-prime mortgages in particular, intensified the problem. Henderson and Pearson (2011) stated that the innovations helped banks create products and services that through their complexity, exploited investors' lack of understanding of financial markets (Henderson & Pearson, 2011). Paul Volcker, former chairman of the United States Federal Reserve and Advisor to former

President Obama, went further, stating that there is "very little evidence" that large amounts of financial innovation in recent times has contributed positively to the economy (Bara et al., 2016).

Despite the recent arguments for the dark side of financial innovation, theoretical economic principles illustrate how financial innovation is practically able to contribute to economic growth.

Financial innovation specifically, is argued to affect growth and creates an efficient financial system through the capital accumulation channel, technological innovation and total factor productivity (TFP) channel. The first channel is predominantly facilitated by banks, financial institutions and intermediaries, mobilising household savings and transforming them into productive resources for investment. Mishra's (2007) argument cements this, stating that the increase in efficiency because of financial innovation, due to an increase in the products and services on offer, improves the ability of the financial system to match the needs of savers to investors, requiring funds for further productive investments. The capital accumulation taking place in the system, due to innovative products and services through this channel, leads to both economic growth and an improved standard of living (Mishra, 2007). The argument for financial innovation promoting the productivity of capital is further supported by Lumpkin (2010).

In addition to their intermediary role, banks and financial institutions have the ability to play a role in the financial system, in terms of financial innovation, either as investors or as innovators themselves (Idun & Aboagye, 2014). Banks have the ability to screen and assess the risk element of potential projects with an innovative element, and choose whether or not to invest; ultimately playing a monitoring role, to ensure adverse results are not realised, to protect all shareholders (Idun & Aboagye, 2014; King & Levine, 1993; Levine, 1997). Alternatively, banks can be the innovators in the system, by creating new banking products and services to better serve their existing and potential new customers. Simultaneously, they are able to mitigate the impact of macroeconomic variables, as well as to enjoy the benefits of being in a monopoly situation in the short-run (King & Levine, 1993; Levine, 1997; Michalopoulos *et al.*, 2009).

The second channel, technological innovation, is encouraged by venture capitalists, who can fund risky projects and technological innovations, with the promise of high payoffs. Finally, in terms of the third and final channel, the TFP channel, which is being endogenously determined,

bank competition and financial innovation impact economic growth through the capital accumulation channel, as well as the TFP channel (Idun & Aboagye, 2014). Through analysis of the channel Idun and Aboagye (2014) suggest that an efficient financial system results in knowledge and technology intensive industries, however the system should not be hindered in its efforts to promote financial innovation, and ultimately, economic growth.

Various models have been developed by academics, to determine the relationship between financial innovation and economic growth. Schumpeter's theories describe how economic growth could be achieved via innovations. He asserts that economic growth is driven by how profit orientated entrepreneurs, through their profit-making endeavours can develop new products. Entrepreneurs enjoy a monopoly in rents in the short-run, which ultimately result in increased competition in the market, due to new entrants eager to share in the profits made by the initial entrepreneurs (Idun & Aboagye, 2014). The subsequent increases in levels of competition, results in entrepreneurs seeking technology in order to improve efficiency and create additional products.

According to Schumpeter's model, entrepreneurs who are unable to fund their endeavours do approach banks for finance and in this role, banks are then able to assess the risk levels and finance entrepreneurs accordingly. This results in the efficient allocation of resources towards productive areas and investments, leading to economic development and growth (Idun & Aboagye, 2014). This process is termed "creative destruction", due to the cannibalisation effect of the new innovations, as entrepreneurs would continue innovating, regardless of an equilibrium state being reached (Idun & Aboagye, 2014). Therefore innovation becomes a key element of disturbance in the economic system, contributing to efficiency, through better mechanisms for functions within the financial system, often at a lower cost (Chikezie *et al.*, 2017)

More recently, the topic has received renewed attention in discussions surrounding the endogenous growth model. Ultimately the relationship is an empirical one (King & Levine, 1993) and the majority of literature following this time period has focused on the multifaceted empirical aspects of the relationship (Samargandi, Fidrmuc, & Ghosh, 2015). Michalopoulos, Laeven and Levine (2009) built on Schumpeter's theories by building a Schumpeterian model, thus, attempting to answer the question of whether financial innovation was needed to achieve sustained economic growth. In the model, entrepreneurs earned profits by inventing new products and services and thus maximising profit. Financiers prioritised screening the

entrepreneurs. It included elements previously not included in existing models in that it modelled technological and financial innovation and not one or the other, as it reflected the profit-maximising actions of individuals. This differs from the traditional Schumpeterian model, where technology evolves, based on the choice of entrepreneurs. The second element previously not included in existing models, is that the screening becomes less effective as technology progresses, therefore information asymmetries widen as the level of technology advances. The model predicts that if financiers continue to innovate, technological innovations will cease to exist and therefore, since technological innovation has an impact on economic growth, economic growth would stagnate if financiers fail to innovate. Therefore, one of the key findings of the work by Michalopoulos, Laeven and Levine (2009) is that technology and financial innovation are positively correlated. This model is referred to as the dynamic model of financial innovation and endogenous growth.

Regulation and innovation are also closely related as argued by (Scylla, 1982) who proposes a regulation framework for financial innovation.

Beck et al. (2016) contributed to the argument for efficient financial systems, stating that the system should not be stalled or hindered, therefore a favourable legal and regulatory environment is key in encouraging financial innovation towards improved economic growth (Beck et al., 2016). In previous literature, the nature of the market structure and regulatory environment had been found to influence the effect financial innovation had on an economy (Beck et al., 2016; Michalopoulos et al., 2009; Miller, 1992). The legal and regulatory environment should not hamper these functions (Michalopoulos *et al.,* 2009), but should instead promote financial innovations towards a financial system able to successfully fulfil these roles (Miller, 1992). Literature also suggests that financial innovation's effect on economic development differs from country to country, depending on the regulatory and market environment of the country in question; regardless of the level of financial development or level of income of said country (Beck et al., 2016).

The nature of the regulation and market structure may hinder innovation, through its ability to impact banks' risk appetite; thereby influencing the extent to which they will innovate. Restrictive regulation may contribute to the negative effects financial innovation may have on an economy. It may also create an incentive for banks to innovate around the restrictive regulation (Beck et al., 2016). This could have a positive or negative effect on the economy,

for example as in the Euromarket or for religious reasons such as with Sharia investment products.

However, a contrasting regulatory system may result in an unstable financial system, creating credit booms and asset bubbles, which ultimately will have a negative impact on growth. According to the World Economic Forums Report on *Connecting Africa's Resources through Digital Transformation,* a balance between a restrictive and free system is therefore required to achieve optimum innovation, with financial stability remaining an integral component of financial development (World Economic Forum, 2012).

Literature has shown that laws are required to protect innovators. If protective laws are not in place, innovators may choose not to innovate. Therefore, the level of innovativeness in a market is dependent on market power and the extent to which legal institutions can put mechanisms in place to protect the financial system.

Financial sectors globally, have undergone changes under the general trend of increased access to technology and the internet, globalisation and deregulation (Ndirangu & Nyamongo, 2015). Technological innovations have an important role to play in financial innovation. Financial Technology (FinTech) refers to the innovation and application of technology that makes financial services and processes more efficient and has the ability to create structural changes, additional industries and to be a catalyst for inclusive growth (World Economic Forum, 2016).

The most notable contribution to financial systems by FinTech, is its ability to increase levels of financial inclusion, particularly within poorer communities, by allowing transactions to take place in the absence of a formal bank account or cash. The introduction of mobile money has enabled millions of airtime purchases, bill payments, wage payments and transferal of money to family members (Thompson, 2017). It has also allowed for the provision of financial options in times of individual financial difficulty, by facilitating access to microcredit and micro-insurance.

2.4 Financial Innovation in Africa Review

Financial innovation's increased uptake in Africa has led to research conducted on the topic. Understanding the context of innovation on the continent is also imperative for the interpretation of results in this study.

Research conducted on the topic of financial innovation on the African continent, comprising fifty-three countries, highlights that the countries are diverse in terms of the structure of economy and economic growth, culture and financial systems (Allen *et al.,* 2011). The continent is the most underdeveloped in the world, in terms of economic growth and financial systems, particularly the Sub-Saharan African region (Allen *et al.,* 2011). The underdevelopment is attributed to high political and economic instability, and a high prevalence of informal financial services and governance issues in both the private and public sectors (Beck et al., 2015). These factors have made African countries inhospitable for financial systems considered conventional, where there is a necessity for efficiency and stability. The difficulty of maintaining a traditional financial system in these environments has highlighted the importance of innovation, and its ability to manage risks and exploit scale economies, to cater to the unique circumstances in African countries. There are disparities in the levels of economic growth and development of financial systems across the various geographical regions, which has a resultant effect on the manner in which adults use financial services and bank accounts (Klapper & Singer, 2015; Maimbo, Saranga, & Strychacz, 2010).

The diversity of African economies, cultures and financial systems, as indicated by *(Allen et al.,* 2011) is evident in the economic growth levels seen across countries. Economic growth in African countries was previously attributed to a high level of natural resources, commodity prices, agriculture, services and improvements in the macroeconomic structures of countries (Mlachila *et al.,* 2013). However, more recently, financial innovation can be seen as having a "leapfrog" effect on economic growth, according to the 2012 World Economic Forum's Financial Development Report. Financial innovation has therefore become an integral part of driving financial inclusion on the continent (Beck et al., 2015).

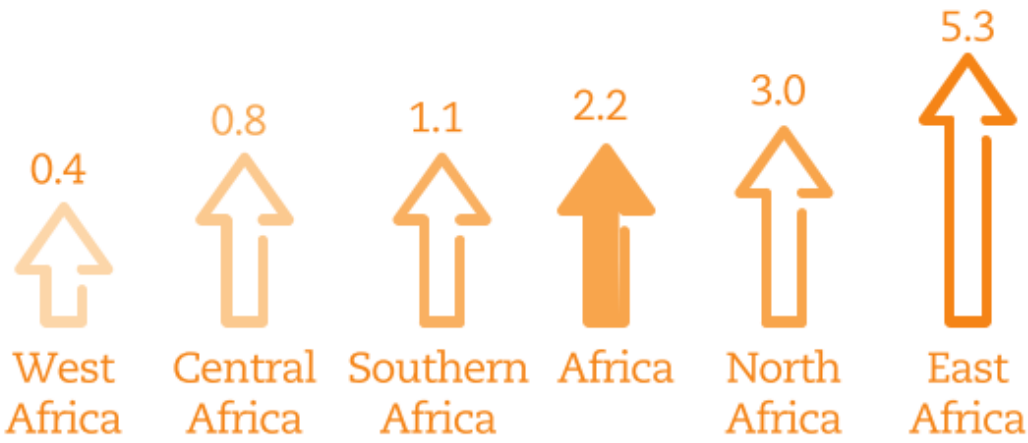
Increasing levels of financial inclusion and financial innovation exists on the continent; resulting in extensive growth; with both banks and mobile phone companies investing in the sector. According to Napier (2011) this introduction has exceeded the expected effects of microfinance and traditional banking services on citizens' access to finance. Existing theory suggests the increased access and usage of financial services on the continent, results in increased economic activity, therefore contributing to economic growth (Bara et al., 2016).

Improved access to finance for business, households and individuals, requires financial innovation to be effective, in order to drive inclusivity to ultimately promote inclusive growth on the continent (Achugamonu, 2017). The growth achieved through increased access to

services, assists in bridging the gap between the informal and formal financial sectors (Achugamonu, 2017; Beck et al., 2015). The gap bridged by financial innovation improvements goes beyond what is possible in the formal sector alone, as the formal sector alone does not result in increased inclusion or financial deepening, with millions of Africans who are unable to access financial services (Klapper & Singer, 2015). Financial intermediation is also impacted by the introduction of financial innovation on the continent, by addressing two of the main issues: high risks and high costs (Beck et al., 2015). The introduction of mobile banking allows services to be provided at a lower cost than what is currently available in the market, by relying on variable costs, as opposed to fixed costs. This grants customers who are likely to make a few small transactions an alternative to the conventional high priced options (Beck et al., 2015). The risk element for service providers is also reduced by allowing a method through which trust can be built over time (Beck et al., 2015).

The increased growth achieved, with increased access and innovation is most evident in East Africa, as seen in Figure 1. Figure 1 shows the GDP growth rate across African regions.

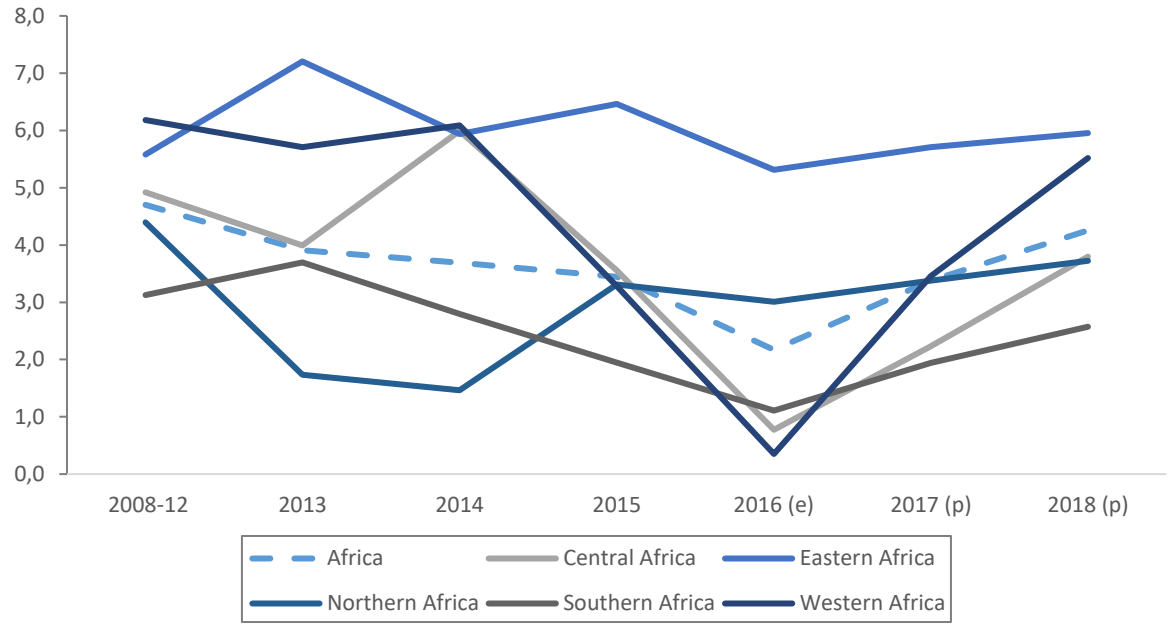
Figure 1: Real GDP Growth across African Regions (2016)



Source: African Development Bank Group (2017)

East Africa consistently maintains the highest economic growth rate across the time period 2008 – 2016, as indicated in Figure 2 and this growth is projected to continue according to the African Development Bank's 2017 Economic Outlook (African Development Bank Group, 2017).

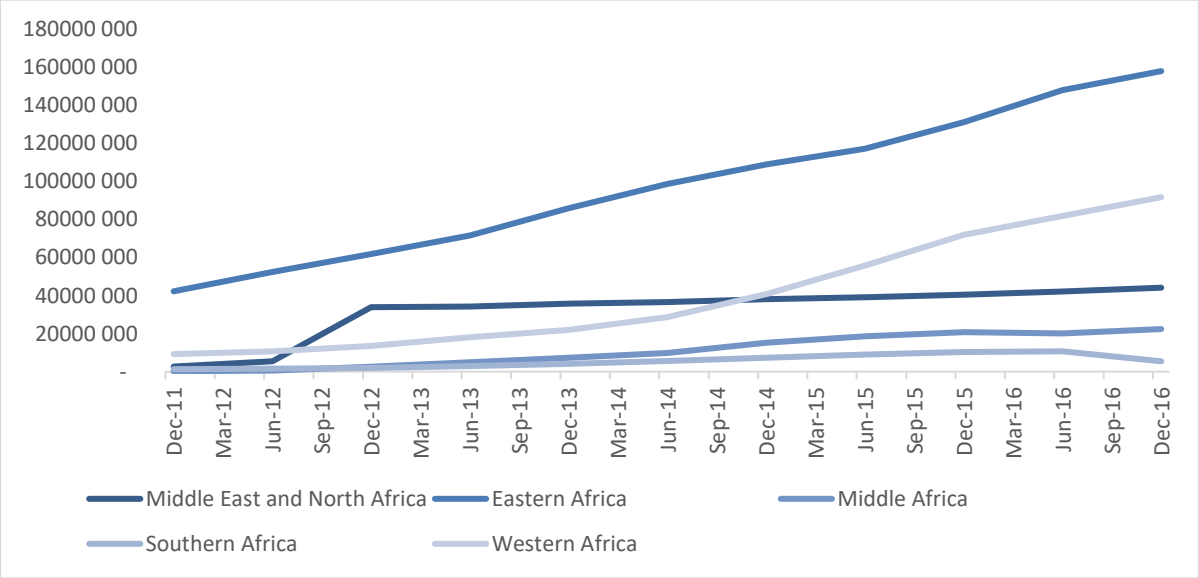
Figure 2: Real GDP Growth (%) across African Regions (2008 - 2018)



Adapted from: African Development Bank Group (2017)

The increasing growth in financial innovation over the same period in the region, as seen in Figure 3, is evidence of the relationship between financial innovation and economic growth.

Figure 3: Adoption of mobile money services in Africa, by region: Registered accounts



Adapted from: GSMA Global Mobile Money Dataset (April 2017)

The rise and improvements seen in financial sectors across African countries have been achieved due to the contribution of multiple role-players. Financial institutions, focused-on and encouraged attention on the topic by law and policy-makers, and the rise of ICT infrastructure

have all contributed to the success of financial innovation on the continent. The individual roles these factors have played are highlighted in this study.

2.4.1 The Role of Banks in Financial Innovation in Africa

A large proportion of the African population do not utilise formal financial services. Global subsidiaries with the ability to provide financial services are also increasing on the continent, however the strategy for banks of this nature, has been to provide services to high income corporate business clients, a bracket that the majority of African citizens do not fall into (Lamikanra, 2015). The lower income retail household bracket, a largely 'unbanked' constituency has, to an extent, been ignored (Lamikanra, 2015).

Banks in Africa have begun exploring and implementing alternative operating models in an attempt to cater to a large unbanked population, particularly those populated across vast geographical areas. Alternatives include, mobile and online banking, mobile branches and third-party agents implementing whichever method is accessible and appropriate.

Large African-based banks have thus made the biggest impact in providing banking services to the masses on the continent and, in doing so, have gained efficiencies, innovation improvements and finally, financial deepening (Lamikanra, 2015).

Beck et al. (2015) and Klapper and Singer (2015) argue that the increase in emerging banks on the continent has increased the level of competition between banks in countries, which has effectively led to an increase in innovation by banks trying to establish themselves in the growing innovative market. According to the IMF, the resultant innovation has in turn, improved access to financial services by Africans, which has been shown to improve GDP growth rates in the relevant countries.

2.4.2 The Role of Policy and Regulation in Financial Innovation in Africa

In addition to banks, African leaders, regulators and policy-makers have also played an important role in the movement towards improved financial services on the continent. The Bill and Melinda Gates Foundation has highlighted the importance of financial innovation, particularly mobile money and its role in providing financial services to the poor. In doing so, the Foundation acknowledges the inability of traditional banks to make a profit by offering these services and highlights the opportunity for mobile money providers to do so (di Castri, 2015). However, according to di Castri (2015), regulatory barriers are slowing down financial

inclusion and the amount of work still required by developing countries to update existing financial regulations, in order to create fewer barriers to entry and a "level playing field" for innovators, remains high.

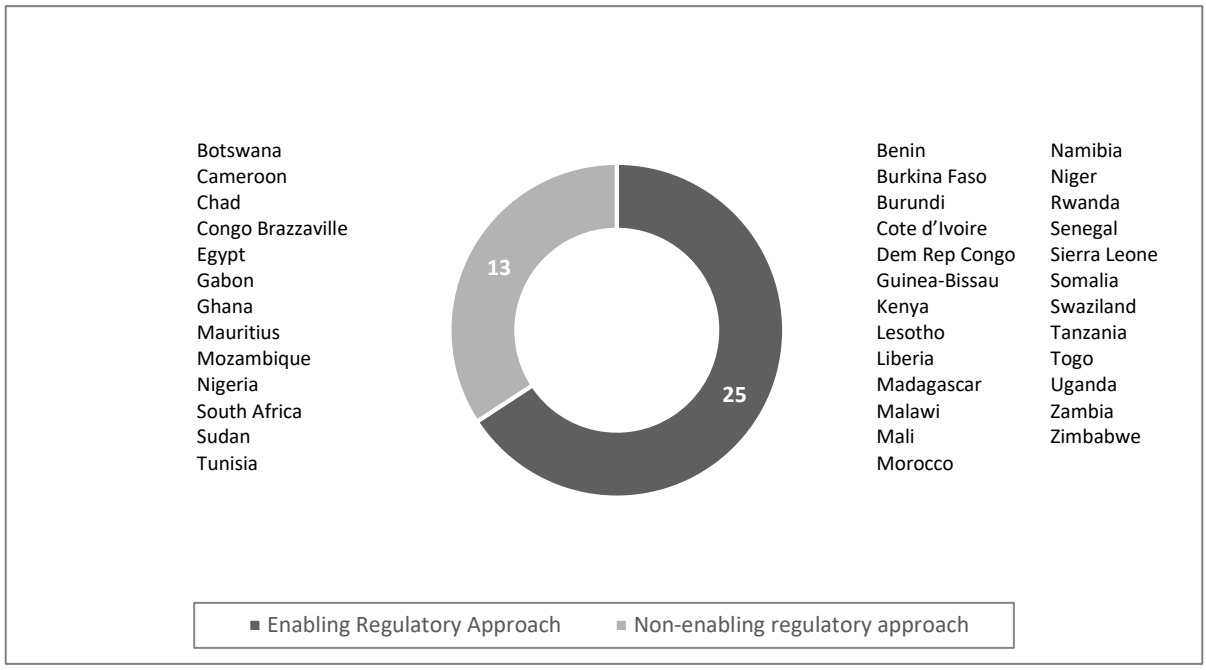
The World Economic Forum's Connecting Africa's Resources through Digital Transformation points out that to a large extent, they have succeeded in leading their own development, thus attracting additional investors to the continent's financial sector (World Economic Forum, 2016). The 2015 Mobile Money State of the Industry Report and evidence from the World Bank's Global Findex Database argues that to enable a regulatory environment it is necessary to encourage the development of mobile money, as well as financial inclusion in general, stating that regulation has the ability to affect the money market (Demirguc-Kunt, Klapper, Singer, & Van Oudheusden, 2015; Global System for Mobile Communications (GSMA), 2015). Di Castri (2015) added that ultimately, regulation should allow for both bank and non-bank institutions to actively participate in providing innovative financial services, on an equal footing. Adjasi, (2015) argued further that regulation should cover three sectors namely the financial sector, the telecommunications sector and competition regulators. Regulation should also allow for partnership and coordination across sectors, to allow for the provision of services, particularly between bank and non-bank providers (Adjasi, 2015; di Castri, 2015). Countries who have successfully implemented regulatory approaches which enable the introduction of financial innovation, like mobile money, are able to improve the level of financial innovation in their countries.

According to the 2015 Mobile Money State of the Industry Report, an enabling regulatory approach[1] existed in more than half of the countries where mobile money was available. Fifty-one of the ninety-three countries have an enabling regulatory approach where mobile money is available globally. Figure 4 and Figure 5 shows that twenty-nine of these are African countries,

[1] By an "enabling regulatory approach" GSMA describes the rules established by the regulator:
• Permit non-banks to issue electronic money (or equivalent) by allowing them to:
  o be licensed directly, OR
  o set up a subsidiary for this business, OR
  o apply for a payments bank (or equivalent) license, OR
  o provides the mobile money service, under a letter of no-objection to the non-bank or its partner bank, pending the approval of a specific regulation,
• AND to impose initial and ongoing capital requirements that are proportional to the risks of the e-money business,
• AND permit them to use agents for cash-in and cash-out operations,
• AND do not prescribe the implementation of specific interoperability models, without allowing for a market-led approach.

with ten countries globally changing their regulations in 2015, seven of which were African countries namely Ghana, Guinea, Mozambique, Nigeria, Sierra Leone and Tanzania (Global System for Mobile Communications (GSMA), 2015).

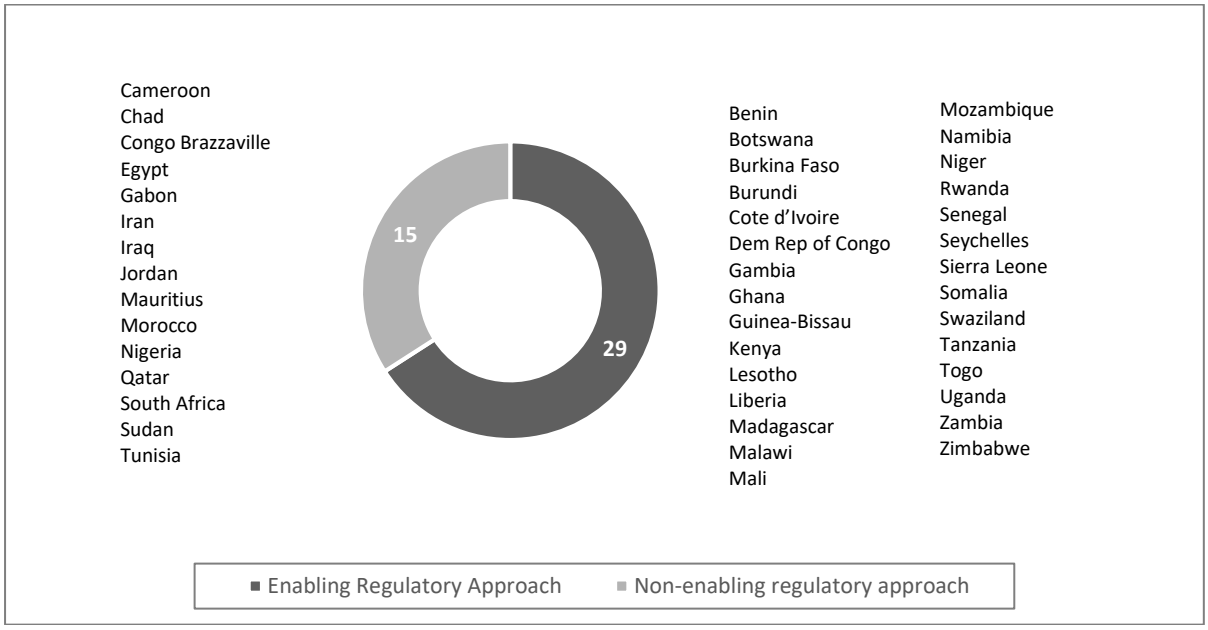
Figure 4: African Countries with Mobile Money by Regulatory Approach (Dec 2014)



Adapted from: di Castri (2015)

Ghana initially took a conservative approach in 2008, but made headway in approving new radically changed regulations in 2015, resulting in it becoming a country with an enabling regulatory approach from 2014 (as seen in Figure 4) to 2015 (di Castri, 2015; Global System for Mobile Communications (GSMA), 2017b). Madagascar and Tanzania also modified their approaches, and Mozambique actively made efforts to improve theirs in the same year (di Castri, 2015). In 2014, Tanzanian regulators made two significant decisions towards benefiting both mobile money customers and the overall growth of the market, by allowing operators to implement interoperability, as well as allowing providers to distribute the interest accrued in the mobile money escrow account (di Castri, 2015).

Figure 5: Number African Countries with Mobile Money by Regulatory Approach (Dec 2015)



Adapted from: GSMA (2017b)

On the other hand, countries with the potential to be large mobile money markets, are behind, in terms of market development and regulatory reform, purposed to allow the participation of non-bank entities. Examples shown in Figure 5 include Nigeria, Egypt, Francophone Central Africa, and all the countries with non-enabling regulatory approaches (di Castri, 2015). Policy and regulation has also hampered the introduction of mobile money to countries, as is the case in Algeria, Angola and South Sudan (di Castri, 2015).

Conservative regulation has proved to be a stumbling block in the implementation of financial innovation in African countries (Napier, 2011). Due to legal limitations regarding the provision of mobile money, banks or non-telecommunication businesses have been unable to provide the relevant mobile money services. This has therefore prevented Mobile Network Operators (MNO's) from providing more mobile infrastructure (Amirehsani, 2014) .

An example of these limitations can be seen in Nigeria. Nigerian regulation is one of the most prominent examples of regulation hindering efforts to promote financial innovation. In a country with the continent's largest economy, fifty-nine percent of Nigerians are not aware of the existence of mobile money (Amirehsani, 2014) and three quarters of the population do not have access to formal financial services (Napier, 2011). The Nigerian Central Bank, to avoid a parallel system from running outside the banking system, forces large telecommunication

businesses to partner with banks, to actively participate in the mobile money market; most notably by providing mobile money outlets, in many cases offering an extensive network of agents. Telecommunication companies have one hundred to five hundred more agents than bank branches representing an untapped market potential of mobile money intermediaries (Amirehsani, 2014). These intermediaries have the potential of conversion to mobile money intermediaries, in the absence of a sufficient or similar bank branch network in the majority of African countries (Amirehsani, 2014).

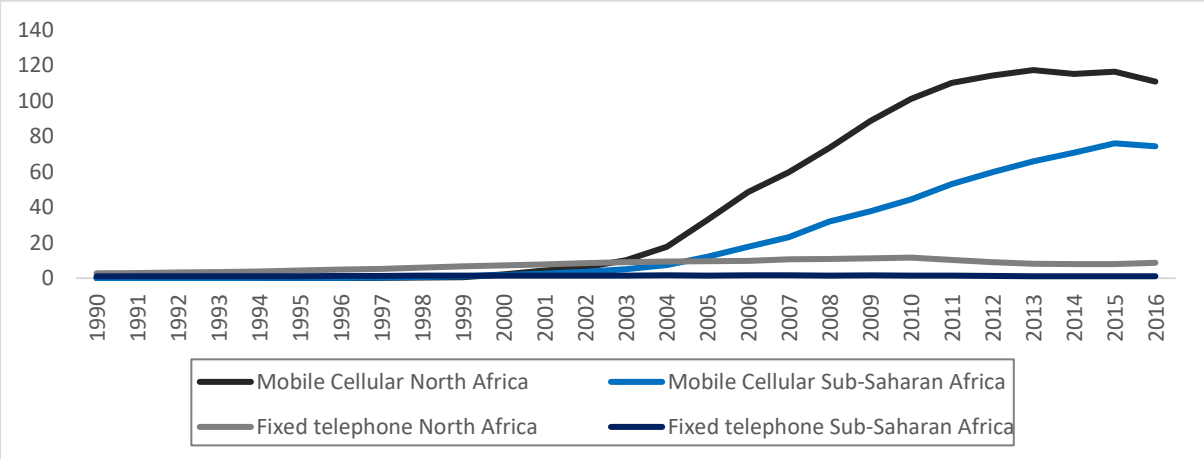
This also illustrates the potential role for the ICT sector in promoting financial innovation in Africa, if partnered with enabling regulation.

2.4.3 The Role of ICT in Financial Innovation in Africa

Finally, in addition to regulations and the banking sector, the growth of the ICT sector has an important role to play. Africa has emerged as the fastest growing region; seeing a forty-five percent growth in mobile subscription overall, and a continental leading growth of seventy-five percent in West African telecommunication (Allen *et al.*, 2011; Ondiege, 2010).

A telecommunication-led roll-out of mobile money has become more common in both East and West Africa; however the latter has lagged behind (Amirehsani, 2014). The ICT sector's development is seen as a signal of the continent's ability to innovate. The sector has become a popular investment area on the continent and has been dominated by growth in the mobile phone industry, as opposed to fixed-line infrastructure; an area generally lacking on the continent, as seen in Figure 6 (Allen *et al.*, 2011) .

Figure 6: Mobile Cellular vs Fixed Telephone Subscriptions Penetration (per 100 people)



Adapted from: World Development Indicators

Levine (1997) argues that it is undeniable that the telecommunications and computing sectors have impacted financial services, while Mwinzi (2014) argues that the rapidly changing technology on the continent increases the channels through which financial services can be provided. Available data illustrates this, and the subsequent effect on growth, with an increase in telecommunication penetration which is indicative of an increase in growth in Organisation for Economic Co-operation and Development (OECD) countries (Aker & Mbiti, 2010).

In 2007, only thirty percent of Kenyan households had bank accounts (Ondiege, 2010) and Ethiopia, Uganda and Tanzania each had less than one bank branch per 100 000 population in the respective countries. However, these ratios do not apply across the continent, with high disparities evident across countries and regions. For example, as opposed to the figures stated, Zimbabwe had more than three, Botswana had nearly four and Namibia had more than four bank branches per 100 000 people in each country (Ondiege, 2010). Overall, in terms of bank accounts, in Sub-Saharan Africa only a third of people have a bank account and also they have difficulty finding funding for micro enterprises (World Economic Forum, 2016). The introduction of financial innovation has shifted the nature of banking in many African countries. Many who previously did not have access to banking services are now able to use financial innovation to conduct their banking.

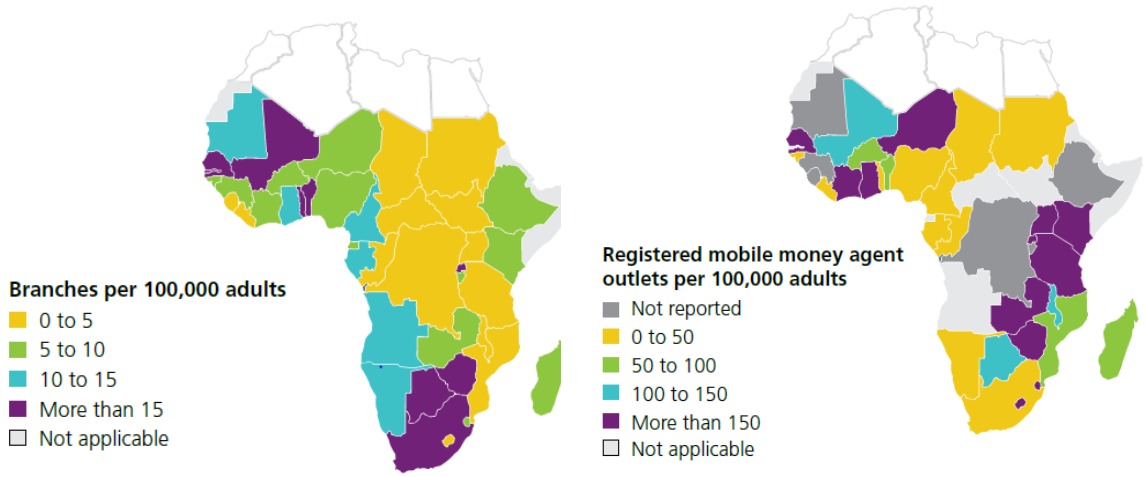
2.4.4 From the Majority of Africa Being Unbanked to More Financial Transactions with Financial Innovation

The high cost of bank branch operation and infrastructure makes it best suited for high density areas, and poorly suited for the areas where many citizens are unbanked in Africa. Populations in Africa are often widely spread across large geographical areas. The lack of infrastructure, physical-geographical isolation, inaccessibility and a lack of financial literacy also increases the costs of effectively providing banking services on the continent. High transaction costs also apply to the few who are in possession of formal bank accounts, when moving cash around (Ondiege, 2010). Individuals' lack of income, documentation requirements for opening a bank account, fees, distance and personal choice have all been indicated as reasons for Africans remaining unbanked (Barr, 2004; Klapper & Singer, 2015).

Banks have realised the potential of the untapped market for the provision of financial services to the unbanked, and the potential of reaching millions of prospective customers. This potential is most prominent in relation to rural customers, sixty percent of which do not have access to formal banking services (Ondiege, 2010). These individuals have moved away from traditional

banking practices towards business models that include mobile and online banking, mobile branches and utilising third-party agents, where possible (Lamikanra, 2015). Figure 7 illustrates this shift in Sub-Saharan Africa. Access to mobile money agents exceeds access to bank branches, in countries where traditional banking services are not available; particularly in Kenya, Tanzania and Uganda (Statistics Department - International Monetary Fund, 2016). In contrast, countries with extensive bank branch networks have fewer mobile money agents available to the public (Statistics Department - International Monetary Fund, 2016).

Figure 7: Physical Access Points for Financial Services in Sub-Saharan Africa[2]

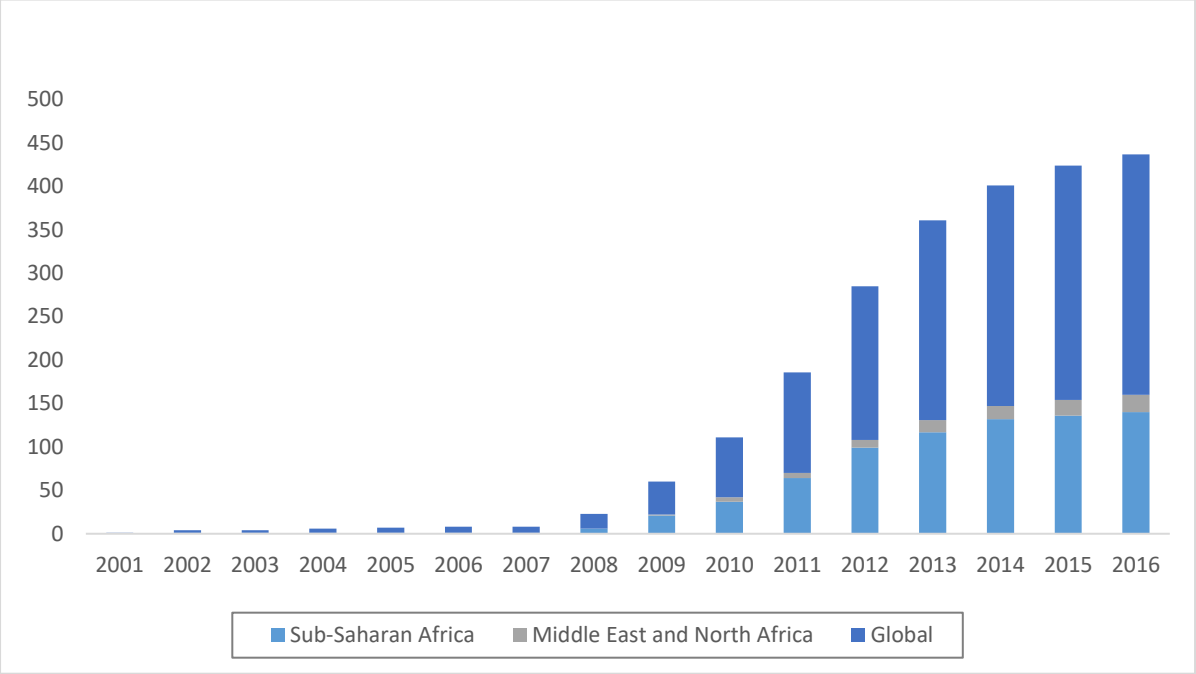


Source: Statistics Department - International Monetary Fund (2016)

While online banking on the continent has increased, it has not seen the same level of success and penetration as mobile banking, due to low internet and broadband subscription on the continent (Ondiege, 2010). Mobile banking has effectively changed the financial inclusion landscape in Africa (Global System for Mobile Communications (GSMA), 2015), and continues to show potential for the future of the provision of financial services in Africa (Napier, 2011). The Sub-Saharan region accounts for just over half the live mobile money services globally, as seen in Figure 8, while North Africa together with the Middle East sees projected growth of fifty percent in future mobile money services (Global System for Mobile Communications (GSMA), 2015).

[2] 2015 or most recent reported data shown. Data on branches cover commercial banks, credit unions and financial cooperatives, deposit-taking microfinance institutions, and other deposit takers where applicable. *Not applicable* represents non-FAS reporters or economies where mobile money services do not exist. *Not reported* represents economies where mobile money services exist but no data levels are reported.

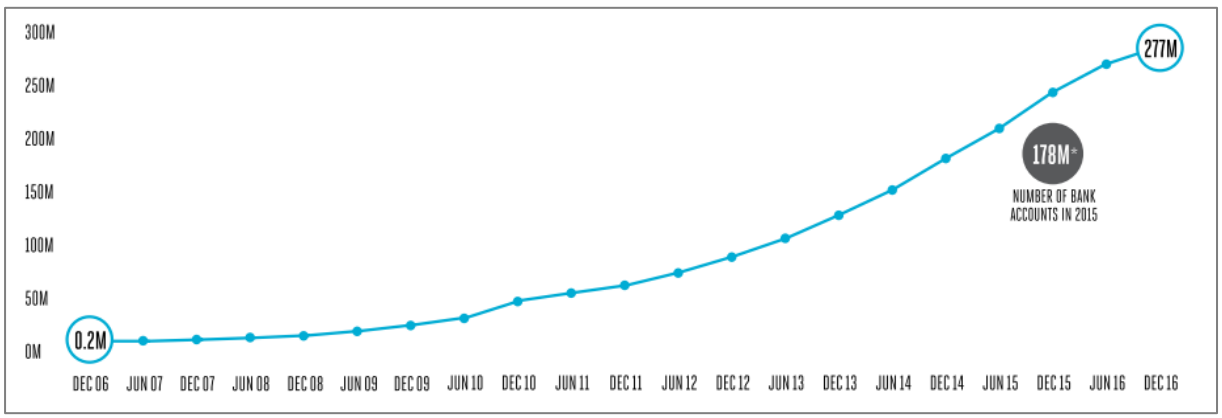
Figure 8: Spread of Live Mobile Money Services by Region (2001-2016)



Adapted from: GSMA Global Mobile Money Dataset, April 2017

The growth in mobile money usage can be attributed to this increased access to mobile phone technology. More than half the adult population in Africa have access to mobile phones, providing an opportunity for the provision of mobile banking (Ondiege, 2010). The trend on the continent has been a movement from populations that were largely unbanked in the traditional sense to populations utilising innovative mobile financial services, like mobile money accounts, as opposed to an increase in access to conventional branches and bank accounts as can be seen in Figure 9.

Figure 9: Growth of registered Mobile Money Accounts in Sub-Saharan Africa



Source: GSMA (2017b)

The growth in mobile money accounts has outpaced that of traditional bank accounts. There are nineteen countries in the world where the number of mobile money accounts exceeds the number of traditional bank accounts. Eighteen of the nineteen are in Africa. Burundi, Cameroon, the Democratic Republic of Congo, Gabon, Guinea, Kenya, Lesotho, Madagascar, Rwanda, Swaziland, Tanzania, Uganda, Zambia, Zimbabwe all fall into this category, with Chad, Ghana and Liberia being the most recent additions to the list in 2014 (Global System for Mobile Communications (GSMA), 2015). In 2012, mobile money accounts surpassed the number of traditional banking accounts in many South East African countries, largely due to the success of Safaricom's M-Pesa.

The introduction of mobile money and mobile banking has seen the concept of branchless banking taking off on the continent. It has provided a cheap, secure and reliable method for doing financial transactions and overcoming the historic barriers of banking, particularly cost and access-related barriers (Klapper & Singer, 2015). The unbanked, previously excluded from the financial system now effectively have a form of access. The provisions of mobile banking have also moved beyond transactional banking only, with the introduction of credit and interest bearing products and services, as well as sector-specific instruments used, for example in the dissemination of agricultural prices (Aker & Mbiti, 2010; Klapper & Singer, 2015).

The assumption that the introduction of financial technology on the continent would be difficult in low income, rural settings has been proven incorrect, with phone ownership in the developing world multiplying, phone subscriptions doubling between 2009 and 2014; particularly in Sub-Saharan Africa (Figure 6) and smartphones becoming more affordable and cheaper, especially in the second hand market (Thompson, 2017). Mobile phones ability to reach wide geographical areas has been proven, and has transformed the economics of service delivery, particularly in terms of reduced costs of financial transactions (Ondiege, 2010).

However, the mobile phone industry is not without challenges. Mobile penetration rates differ from as low as ten percent in Ethiopia to one hundred percent in Gabon (Ondiege, 2010). Challenges to improved mobile penetration in countries include high taxes, some as high as thirty percent in countries like Tanzania and Uganda, a lack of signal in large areas, as well as illiteracy in some areas (Ondiege, 2010).

The disparities between financial innovation and specifically mobile financial innovation expansion in African countries illustrates the need for more comprehensive infrastructure, both on a regional and country level, where possible.

2.4.5 Current Financial Innovation in Africa

As shown above, financial innovation has taken off on the continent, with varying products and services achieving differing levels of uptake and success. A number of new products and services have been introduced across the continent, particularly in the last two decades, contributing to the structure of a country's banking and financial systems, cross border banking (Bara et al., 2016) and the level of financial inclusion in countries.

The financial services sector on the continent has expanded exponentially in recent years, in some countries. The sector, previously unexplored, underinvested and underserving its constituents; is now one of the main economic prospects on the continent. Furthermore, the development of the financial sector has been made a priority for policymakers across the continent (Lamikanra, 2015). The following sections present an overview of financial innovation and its effect on the financial services sector in the various regions in Africa.

2.4.5.1 Current Financial Innovation in North Africa[3]

The North African region boasts the second highest GDP growth rates in 2016 (Figure 1). The spill-over effects of the Arab Spring[4] in North African countries Tunisia, Egypt and Libya, as well as reduced oil production in Libya, has slowed down economic growth in the region, despite recovery seen in Egypt and Algeria (African Development Bank Group, 2017).

The North Africa region remains the region in Africa with the most non-enabling markets in terms of regulation (Global System for Mobile Communications (GSMA), 2017b). None of the countries with mobile money services, namely Egypt, Morocco and Tunisia, have enabling regulation (Global System for Mobile Communications (GSMA), 2017b). However, Egypt and Morocco have committed to the Alliance for Financial Inclusion's (AFI) Maya Declaration, committing to putting enabling regulation in place in the future.

Financial innovation in the North African region is limited, when compared to the rest of the African continent. Therefore, few examples of financial innovation exist for the region. One example can be seen in Egypt. Banking innovations and the movement away from traditional banking in Egypt has led to innovative lending practices to microenterprises by Banque Misr, Egypt's largest bank (Napier, 2011). The crucial differing factor for the service is the use of

[3] North African countries include Algeria, Egypt, Libya, Morocco and Tunisia.
[4] A wave of pro-democracy protests and uprisings that took place in the Middle East and North Africa between 2010 and 2011, challenging some of the region's authoritarian regimes.

young graduates undergoing training by experienced loan officers to become loan officers themselves. The graduates entered the market with no notion of what constituted a high risk loan client. The program offered clients incremental stepped loans, enabling them to increase their loan upon successful payment of a smaller existing loan, with loan repayments being close to a hundred percent (Napier, 2011).

Positively, the region has begun exhibiting evidence of future growth in the financial innovation and Fintech sector. Governments and policy makers have begun incorporating the sector into their thinking towards the expansion of their economies (D'Cunha, 2017). More specifically, two accelerator-schools have been launched to nurture start-ups in Cairo, Egypt, and Islamic banks are investing in digital finance (D'Cunha, 2017).

The state of financial innovation in North Africa differs greatly from that of Sub-Saharan Africa. The following sections present an overview of financial innovation in Sub-Saharan Africa, as well as the regions within it.

2.4.5.2 Current Financial Innovation in Sub-Saharan Africa

Sub-Saharan Africa covers the East, West, Central and South Regions of the continent. Financial innovation in the region is led by mobile money and its related services. Mobile money in Sub-Saharan Africa, drives adoption in Africa and globally. In 2016, there were seven countries in Africa, where at least forty percent of the population utilised mobile banking (Global System for Mobile Communications (GSMA), 2016), and two countries in 2015 namely Kenya and Tanzania showed increased utilisation. (Global System for Mobile Communications (GSMA), 2017a). The growth of mobile bank accounts has outpaced the growth of bank accounts, at traditional financial institutions in the region, particularly the West African region (Global System for Mobile Communications (GSMA), 2016).

a. Current Financial Innovation in West Africa

The West African[5] region previously had a largely fragmented mobile money market, causing it to lag behind its Eastern counterparts in terms of usage of mobile money services (Amirehsani, 2014). More recently, the region has expanded since 2011, doubling the number of live mobile money services in five years (Global System for Mobile Communications (GSMA), 2016) to be become a front runner in terms of mobile money in Africa. The region

[5] West African countries include Benin, Burkino Faso, Cabo Verde, Cote d'Ivoire Gambia, Ghana, Guinea, Guinea – Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Saint Helena, Senegal, Sierra Leone and Togo

now boasts a third of all active mobile accounts in Sub-Saharan Africa, compared to ten years prior (Global System for Mobile Communications (GSMA), 2016). This could be attributed to the fast rate at which agent networks grew in the region and, the thirteen out of fifteen countries with enabling regulation, made it easier for banks and non-banks to offer mobile money services (Global System for Mobile Communications (GSMA), 2016).

Western Africa has also seen innovations within the banking sector, particularly in Ghana, with increasing competition within the banking sector in the country (Idun & Aboagye, 2014). The range of products has increased. It now includes international funds transfers, school fee loans, negotiable certificates of deposits, car loans, consumer/hire purchase loans and travellers' cheques (Hinson et al., 2006). The manner in which day-to-day banking is done has also changed in the country, with the introduction of personal computer, telephone, internet, branchless and SMS banking, and an increase in branches and automated teller machines (ATM's) across the country (Idun & Aboagye, 2014). An emphasis on innovation by payment providers in particular, has allowed mobile payments to increase, including mobile bill payments and government payments (Global System for Mobile Communications (GSMA), 2016). The introduction of these services, grants citizens access and options when choosing the method most suited to their needs.

The shift in everyday banking habits, has led to an increase in savings mobilization, development financing and service delivery, driven by telecommunication networks and advancement in computer technology in the country. If savings are successfully mobilised and channelled to productive sectors it could result in economic growth (Idun & Aboagye, 2014).

The innovations in the country have also included low technology innovations. The creation of informal networks of Susu collectors in Ghana has also facilitated the distribution of loans. The service provided by Susu collectors include banking of market traders daily takings on their behalf, for a small fee (Idun & Aboagye, 2014). The network has expanded with each Susu collectors having between three hundred to one thousand clients each (Napier, 2011). Barclays Bank in Ghana has changed the way in which loans are distributed in the country, by incorporating these informal networks into its business and it has been further utilised to gain information on the risk rating of clients, by offering microloans to clients they were previously unable to reach (Napier, 2011). The system's uptake was successful with $375 000 in disbursements to a thousand clients in the first seven months, amounting to $2m deposits for the bank, and one hundred percent loan repayments (Napier, 2011). However, a dark side to

the innovation in Ghana has also become apparent. The Ghana Cooperative Susu Collectors Association (GSCA) argues that, due to the large number of illegal Susu operators, it has caused a threat to the national security of the country. The GSCA continues, arguing that people saving their money with cooperatives are at risk of losing everything, should there be a default in payment (Yeboah, 2016).

Also, in West Africa, Cote d'Ivoire, long having been a hub for Francophone African immigrants, has lately seen a major mobile money partnership between Western Union, the largest money transfer provider in the world, and MTN. The partnership is modelled on a 2012 partnership between the two companies in Uganda. The South African telecommunications company has further eased international remittances through the rollout of low-cost mobile payment services between Cote d'Ivoire and Burkina Faso, and Cote d'Ivoire, who followed a similar offering from its French rival, Orange (Amirehsani, 2014). Orange, has also enabled school registration fees to be paid using mobile money in Cote d'Ivoire.

b. Current Financial Innovation in East Africa

While West Africa has made significant progress in terms of mobile money, East Africa,[6] specifically Kenya, is home to one of the most recognised mobile phone payment products on the continent, M-Pesa. The region is historically known for the inroads made with regard to financial innovation.

Almost half the country's GDP goes through M-Pesa (Amirehsani, 2014; World Economic Forum, 2016), and sees increasing proportions of both deposits and general transactions (World Economic Forum, 2016). M-Pesa has also gained popularity in other East African countries, particularly Tanzania (Amirehsani, 2014), although the uptake of M-Pesa was slower in Tanzania as well as in Nigeria, in West Africa. The negative influence of regulations, as has been the case in many African countries, as well as fragmented market places (Napier, 2011), has slowed down the uptake of M-Pesa and alternative mobile money products and services. An example of a fragmented marketplace negatively affecting the penetration of mobile money was when M-Pesa launched in Tanzania. Vodacom, the company responsible for the mobile service's promotion, had a market share of only forty percent, with at least two other

[6] East African countries include the British Indian Ocean Territory, Burundi, Comoros, Djibouti, Eritrea, Ethiopia, the French Southern Territories, Kenya, Madagascar, Malawi, Mauritius, Mayotte, Mozambique, Reunion, Rwanda, Seychelles, Somalia, South Sudan, Uganda, the United Republic of Tanzania, Zambia and Zimbabwe.

competitors in the country also trying to penetrate the market with mobile money services, namely Zain and Zantel (Napier, 2011). Vodacom also only had 5.2 million subscribers as opposed to Safaricom's 12.5 million in Kenya (Napier, 2011).

With regard to regulation, within the M-Pesa example in Nigeria, the central bank showed concern about the repercussions of having "parallel financial systems" run by MNOs, therefore outside the system over which it had no control (Napier, 2011). This is a common concern for central banks across the African continent (Napier, 2011). While the concern shown is not without reason, it has however had negative consequences in that three quarters of the continent is still unable to access finance (Napier, 2011). Regulatory conservatism therefore has created a major roadblock for the widespread expansion of mobile money services (Napier, 2011).

In contrast to regulations in Nigeria, the growth in financial inclusion in Kenya is driven and supported by regulatory changes in the country. The Central Bank of Kenya (CBK) made changes to the country's legal and regulatory framework sector (Ndirangu & Nyamongo, 2015). The changes allowed the promotion of electronic payments and financial inclusion to flourish, thereby increasing financial transactions and settlements in the country (Ndirangu & Nyamongo, 2015). The National Payments Systems Act of 2011; the introduction of guidelines for the manner in which electronic retail transfers and e-money are conducted in 2012; new agency banking guidelines in 2010; and the licencing of deposit-taking micro-finance institutions, are all evidence of the country making a concerted effort to support the growth of its financial sector (Ndirangu & Nyamongo, 2015).

Another East African country, Rwanda, is also becoming known as a high-technology hub on the continent, with one of the fastest GDP growth rates, and is also the most competitive and active reformer of the country's business environment on the continent (World Economic Forum, 2016). Positively, in Uganda, another country where mobile money is actively pursued, mobile money has increased its participation by forty percent of the population since its inception eight years ago, in March 2009 (Munyegera & Matsumoto, 2017). Inspired by M-Pesa, MTN launched Uganda's first mobile money network called "MTN Mobile Money". The introduction proved successful for MTN as a mechanism to increase their market share, by widening the range of services available in the country. Competitors soon followed suit with the introduction of "M-Sente" by Uganda Telecom in March 2010, "Warid Pesa" by Warid Telecom in December 2011 and finally "Orange Money" by Orange Telecom in the first six months of 2012 (Munyegera & Matsumoto, 2017).

In addition to being the home of mobile money, the East African region also boasts the highest GDP growth rate, when compared to other regions in Africa (Figure 1 and 2). The average gross domestic product in the region however varies significantly from country to country. In some cases, countries have high growth rates despite low average GDP, making them some of the fastest growing economies in the world.

Therefore overall, the East Africa region is a leader in terms of mobile money and economic growth on the African continent.

c. Current Financial Innovation in Central Africa

The fourth region in Sub-Saharan Africa is Central Africa.[7] The majority of countries in the Central African region, are dependent on oil, and therefore Brent Crude oil prices, for their economic growth levels (European Investment Bank, 2016). The growth rates in the region declined in 2015, due to a reduction in public investment, as well as a decline in oil production in the country. Growth rates remained low in 2016 at point eight percent making it the region with the second lowest growth rate on the continent (Figure 1). However, forecasts for growth in the region are positive, predicting a more dynamic economy from 2017, with an annual growth of approximated three and a half percent until 2021, attributed to expected fiscal consolidation (European Investment Bank, 2016).

With regard to financial inclusion in the region, banking penetration rates in the region are some of the lowest in the world (eleven point eight percent in 2014), particularly the CFA Franc monetary zone, namely Cameroon, Central African Republic, Chad, Republic of Congo, Equatorial Guinea, and Gabon (European Investment Bank, 2016; Klapper & Singer, 2015). The rates seen are significantly lower than the rates seen in the rest of the Sub–Saharan region (thirty-four percent) (European Investment Bank, 2016). Financial inclusion does however differ from country to country, with Gabon having a relatively high penetration rate of thirty-three percent, similar to the Sub–Saharan average, compared to Cameroon and Chad's penetration rates of twelve percent respectively (European Investment Bank, 2016); and finally the Central African Republic and Democratic Republic of Congo, where less than five percent of adults have formal bank accounts (Klapper & Singer, 2015). The stumbling blocks attributed

[7] Central African countries include Angola, Cameroon, Central African Republic, Chad, Congo, the Democratic Republic of Congo, Equatorial Guinea, Gabon, Sao Tome and Principe.

to these low rates include the relevant economies' lack of diversification, lack of income and finally the geographical distance from financial institutions (European Investment Bank, 2016).

The nature of regulation in the region has played a large role in inhibiting the potential impact of mobile banking in the region, particularly the illegality of credit institutions providing electronic money until 2015 (European Investment Bank, 2016). Due to this, the mobile phone accounts, like bank account penetration in the region, remains low (European Investment Bank, 2016).

A large percentage of Central Africans, thirty-seven percent, use only informal banking services like community savings clubs (Klapper & Singer, 2015). Angola is the leading country in Africa in terms of utilising mobile phones to pay bills (Adjasi, 2015), however overall, mobile banking in the region is limited when compared to other regions in Africa, particularly East Africa (European Investment Bank, 2016).

Cameroon is the leading country in the region in terms of mobile banking. It is one of nineteen countries in Africa with more mobile accounts than bank accounts (Global System for Mobile Communications (GSMA), 2015) and maintains a low banking penetration. The low penetration is attributed to the concentration of banking facilities in the urban and the suburban areas of the country, and a lack thereof in rural areas and the high cost of formal banking, particularly in relation to the average income of individuals in the country (European Investment Bank, 2016). The International Monetary Fund (IMF) has made further recommendations to Cameroon authorities, to promote financial inclusion. The network of banking facilities will need to be extended to rural areas, as well as the further development of the mobile financial services industry (European Investment Bank, 2016).

Gabon is one of the many countries in the Central African region where the economy is sustained by the oil sector, and therefore has recently been negatively impacted by the fall in Brent Crude oil prices. With the introduction of new financial institutions and banking services, the country now boasts the highest financial inclusion rate in the Central African region (thirty-three percent), similar to rates seen across Sub-Saharan Africa (European Investment Bank, 2016). More than forty percent of the country's population uses mobile banking, making it one of nineteen markets in Africa where the number of mobile accounts outrank their formal bank counterparts (Global System for Mobile Communications (GSMA), 2015).

Actions by the country's authorities contributed to the uptake, namely the introduction of a requirement for public officials, students, pensioners and non-permanent employees to open accounts in local banks (European Investment Bank, 2016). However, despite advances made, the availability of banking services remains concentrated in urban areas (European Investment Bank, 2016).

d. Current Financial Innovation in Southern Africa

The final African region, the Southern African[8] region, consists of many countries where increased economic growth rates have been seen (Bara et al., 2016). Economies are well capitalised and dynamic, particularly Botswana, Namibia, Mauritius and South Africa (Allen *et al.,* 2011). Banks and private companies in Southern Africa have contributed to financial innovation in their countries (Allen *et al.,* 2011). However it is countries like Lesotho and Swaziland that have seen higher mobile phone utilisation for payments and transactions than their more financially developed counterparts (South African Reserve Bank, 2014).

The effects of financial activity in Southern African countries is clear, with an increased volume in trade seen, as well as more efficient financial transfers (Maimbo *et al.,* 2010). The increased level of financial transfers seen can be attributed to more integrated financial systems. An example of a financial innovation by a private company contributing to financial activity is Shoprite's Money Transfers. Approximately forty percent of the US$1 billion in remittances flows out of South Africa to other countries in the Southern African region utilising this mechanism (Maimbo *et al.,* 2010; Mochiko, 2015; Ramsamy, 2014). International remittances exceeds developmental assistance and foreign direct investment combined, and provides access to money needed for subsistence, business and economic development (Napier, 2010). However, a potential risk exists as it is open to money laundering, channelling of funds to terrorists, illegal forex trade and finally, tax evasion (Napier, 2010).

Additional companies who have successfully innovated and increased access to finance via financial innovation is Hollard in partnership with Pep. By utilising Pep's existing infrastructure, Hollard can provide financial services without investing in expensive infrastructure.

First National Bank (FNB) has also contributed to financial innovation in the region increasing financial inclusion by increasing the availability of financial services in remote areas. Through

[8] Southern African countries includes Botswana, Lesotho, Namibia, South Africa and Swaziland.

the distribution of FNB Mini ATMs, the bank has succeeded in providing banking services to masses of individuals in Southern Africa where previously were not able to do so, due to their remote geographical locations (Napier, 2010). The ATMs are situated in small shops and have the ability to provide complete transactions (Napier, 2010). They use GPRS technology, as opposed to landlines, thus eliminating the time delay for the necessary infrastructure to be installed, and a reduction of potential services interruptions, cable theft and communication costs (Napier, 2010). The ATMs are in all Southern African countries and provide benefits for both the merchant housing them, as well as consumers with access to them. The merchant on average, sees an increase in turnover of fifteen to twenty percent, and allows the merchant to hold less cash on the premises (Napier, 2010). The community also ultimately benefits, as the money drawn, is likely to be spent in the vicinity, therefore increasing the micro economic activity in the area. Finally, individuals also gain access to the formal banking system, potentially drawing people into a system which previously they were not a part of.

Another bank that has contributed to increasing financial innovation and financial inclusion is Bank Windhoek, who have rolled out bank branches in remote areas in Namibia (Napier, 2010).

Individual countries in the region have also encouraged financial innovation by reforming their financial sectors. The reforms create an enabling and accommodating environment for financial innovations to flourish, particularly microfinance, mobile money and mobile banking, all of which contribute to increased levels of financial inclusion (Simpasa, Odour, Moyo, & Nandwa, 2014), as well as increased economic activity. The inference is that an increase in access and usage of innovative banking solutions like mobile financial services generates higher economic activity, contributing to higher economic growth (Bara et al., 2016).

In terms of regulation, South Africa, specifically the South African Reserve Bank has committed to making payment systems and the regulation thereof a priority in the country. Payment stakeholders argue for a renewed focus from both regulators and central banks on more innovative payment systems (Fin24, 2016). The industry is said to be entering a new phase in terms of payments systems and financial regulation, with the SARB committing to new overarching legislation (Fin24, 2016). The importance of financial stability and protection against fraud is highlighted while, at the same time allowing consumers to benefit from financial innovations (Fin24, 2016).

However, an overreliance on the regulator is also highlighted by payment stakeholders arguing that regulators should not hamper innovation but should offer financial stability, including

cybersecurity, infrastructure and an efficient financial system, creating a balance between regulation and innovation (Fin24, 2016).

The context provided of the current state of financial innovation on the African continent, creates a background to be considered in the review of research conducted on the empirical relationship between financial innovation and economic growth.

2.5 Empirical Review: Financial Innovation and Economic Growth

Several empirical studies have been conducted to assess the impact financial innovation has on the growth rate of a country. Beck et al., (2000) and King and Levine (1993), succeed in showing that financial development has a positive relationship with economic growth. King and Levine (1993) confirm Schumpeter's earlier theories by showing that higher levels of financial development lead to improved rates of achieving economic growth, physical capital accumulation and economic efficiency. They also find that financial development is a good predictor of future long -term economic growth. Therefore, the study is integral in showing that finance does not necessarily follow from economic growth, nor is the relationship between financial development and economic growth a parallel one. While the study confirms earlier theories of Schumpeter, it also negates Levine and Renelt (1992), who finds only weak, fragile partial correlations between growth and a range of economic indicators. In a separate study, the link between financial development and innovation and reduced income inequality and poverty alleviation was also shown (T Beck, Demiguc-Kunt, & Levine, 2006); which are all potential contributors to economic growth.

Samargandi et al., (2015) conduct a study assessing the relationship between financial development and economic growth, specifically in middle to low income countries. They find that a u-shaped, negative relationship exists between the two metrics in the long-run. While this study contrasts the results of King and Levine (1993) it is similar to results seen by Loayza and Ranciere (2006), whose study show that financial development negatively impact economic growth in the short-run, but not in the long-run (Loayza & Ranciere, 2006). However, Samargandi et al., (2015) did note that the impact of financial development varies across countries, which is largely due to the varying nature of economic structures, institutional quality and financial markets within said countries.

In addition to research regarding financial development and economic growth, the relationship between financial innovation and growth has also been investigated empirically. Beck et al.,

(2000), Dynan et al., (2006), Hao and Hunter (1997), Aghion, Howitt and Mayer-Foulkes (2005), Michalopoulos et al., (2009) and Arcand, Berkes and Panizza (2012) find a positive relationship between financial innovation and economic growth. Looking at these author's findings more closely, Beck et al., (2016) show a positive net effect of financial innovation on growth, and that financial innovation is linked to higher growth and industries, with better growth opportunities and stronger GDP per capita. The study finds that industries that are dependent on external financing and are reliant on innovation, see higher growth rates when linked with financial innovation. However, these industries also see higher growth volatility when linked to financial innovation.

According to Dynan et al., (2006), financial innovation should be included as a contributing factor to the economic stabilisation seen in the US in the mid-80s, while Hao and Hunter (1997) find that financial innovation has a direct impact on economic growth. In addition to their overarching finding, Hao and Hunter (1997) also measure the effect that financial depth and second stage financial innovations has on a country's economic growth rate. They find a positive relationship between financial development and improved economic growth, when using cross country econometric results Hao and Hunter (1997).

Also contributing to the empirical evidence of a positive relationship between financial innovation and economic growth, Aghion, Howitt and Mayer-Foulkes (2005) and Arcand, Berkes and Panizza (2012) highlight the importance of acknowledging the double edged sword of financial innovation. The opportunities and risks associated with financial development advocate for policy and regulation to mitigate the potential negative impacts of the risks. Both studies emphasize the importance of innovative activity of financial intermediaries, as compared with the level of financial development, as being a crucial element to promote a country's growth rate.

Michalopoulos et al., (2009), building on the work by Aghion, Howitt and Mayer-Foulkes (2005) show that countries that encourage financial innovation speed up the rate at which the country will contribute to the growth rate of its technological leaders. They also argue that while financial innovation reflects the decisions of profit maximising individuals, regulation and policy have a role to play in promoting technological change and economic growth. Michalopoulos et al., (2009) also conduct a panel of GMM estimations and find that financial innovation, and not financial development, improve the rate of economic growth, especially in countries poorer than the economic leader in the region. Their Schumpeterian model predicts

that financial innovation is essential for sustaining economic growth, showing that financial innovation and economic growth will eventually stagnate unless financiers innovate. Their empirical evidence that innovation and growth evolve together endogenously, are in line with earlier theories on the topic. They add to the literature by showing that in contrast to conventional theories showing only financial development affecting technological innovation and growth, their model shows that financial innovation in fact, plays an important role in the rate of technological innovation, as well as growth. Through their model predictions, they highlight the importance of policy and regulation to ensure that financial innovation is encouraged, to avoid slowing economic growth, particularly financial innovation that assists in screening technological entrepreneurs.

The studies conducted by Beck et al., (2000), Dynan et al., (2006), Hao and Hunter (1997), Aghion, Howitt and Mayer-Foulkes (2005), Michalopoulos et al., (2009) and Arcand, Berkes and Panizza (2012) focus on developed economies in continents outside Africa. Very little empirical research has been conducted to test the relationship between financial innovation and economic growth in Africa.

Adu et al., (2013) conduct a study that investigates the long-term effects of financial development, on growth in Ghana, and specifically whether the choice of proxy for financial development impacts the results. They find that the growth effect is impacted by the choice of proxy, concluding that whether financial development has a positive or negative effect on growth is reliant on the choice of measure for financial development (Adu *et al.,* 2013). Credit extended to the private sector as ratios to GDP and total domestic credit are beneficial to growth, while broad money stock is not. They inferred that the influx of technological innovations driven by the increase in information and communication technology has improved the level of efficiency in banks to endeavouring to mobilise saving and allocates such levels in a more productive manner (Idun & Aboagye, 2014).

Idun and Aboagye (2014) test the relationship between bank competition, financial innovations and economic growth in Ghana. They find that a positive relationship exists between financial innovation and economic growth in the short-run. However, in the long-run the relationship is negative. The study also shows bi-directional Granger causality between financial innovation and economic growth, as well as between financial development and financial innovation.

Contrasting with the Idun and Aboagye (2014) results, Bara, Mugano and Le Roux's (2016) study focuses on the SADC countries, and find that financial innovation generally has a positive

effect on economic growth in the long-run, but acknowledged that the relationship varied, depending on the variable used to measure financial innovation. Bara, Mugano and Le Roux (2016) explain that the positive relationship found is weakened by the underdevelopment of financial sectors in many SADC countries, and that innovation in a country's financial sector is reliant on the development of its financial sector. They went further, arguing that measures of financial innovation using private credit and broad money has negative coefficients derived from variables that reflects the impact of levels of financial development on growth, given the negative relationship between the two variables in the SADC (Bara et al., 2016).

Additional potential explanations include the constant reform of financial sectors in the SADC region to accommodate microfinance, mobile money and banking. These reforms are put in place in an effort to increase access to finance and promote efficiency in the financial systems; ultimately contributing to improved economic growth (Simpasa *et al.*, 2014).

Bara, Mugano and Le Roux's Granger causality tests also contrast with Idun and Aboagye's, finding no causality in either direction, between financial innovation and economic growth both in the long- and short-run. Bara, Mugano and Le Roux infer from the causality findings that the continued financial innovations in countries, despite having positive effects has no significant causal impact on the rate of economic growth, nor does growth affect financial innovations. Therefore, they argue there is an opportunity to increase financial innovation in the SADC, without being inhibited by a country's economic growth. They also argue for financial innovation to prioritise mobile banking, as it fulfil multiple roles simultaneously, namely, decreasing the amount of unbanked citizens, providing financial deepening, as well as improving access and convenience for previously unbanked individuals (Bara et al., 2016). Finally, Bara, Mugano and Le Roux argues for SADC countries to cooperate to increase the amount of funding available for contribution towards further financial innovations. The individual countries, do not have the capacity to support or attract sufficient investment for the financial and technological infrastructure required (Bara et al., 2016).

Focusing on the relationship between economic growth and financial innovation in Nigeria, Chikezie et al., (2017) test the relationship between financial technological innovations collectively, as well as individually. The results show that the innovations collectively, do not have a joint positive effect on growth but instead has varying effects individually. ATM transactions, online transactions, POS services and mobile payments were tested, with all instruments showing a positive effect on growth, except for POS services. They conclude that

financial innovation does not have the desired effect on the country's economy and attributes this to the lack of depth established by the instruments in the country. In terms of causality, their results show no causality between economic growth and financial innovation, similar to the results of Bara et al., (2016b) . The Granger test conducted shows no causality between financial innovation and economic growth in Nigeria, in the time period covered (Chikezie et al., 2017). In another study also focusing on Nigeria, looking specifically at banking agents as a financial innovation, Achugamonu (2017) finds the geographical spread of the banking agents impacts financial growth positively, particularly in poorer, financially inactive communities, contributing to inclusive growth.

In Kenya, financial innovation has a positive impact on growth, in this case a significant one. Mwinzi (2014) shows that in Kenya, financial innovation has a significant, positive impact on economic growth. The study shows that mobile transactions has an important role to play in the country's economic growth. Going into more detail, Mwinzi (2014) shows that financial innovations in payment systems, specifically has a positive effect on economic growth, with the finding being supported by the correlation between the GDP and the value of Real Time Gross Settlement, the value of cheques cleared, mobile money transactions and of the automated clearing house.

Similarly in Ghana, Mannah-Blankson and Belnye (2004) used co-integration techniques to also find a positive relationship between financial innovation and the demand for money. In the same vein, Ansong, Marfo-Yiadom, and Ekow-Asmah (2011) find a positive relationship in Ghana, when using the same techniques to test the long-run relationship between financial innovations and savings. They use perpetual index and broad money (M2), instead of narrow money (M1), as proxies for financial innovation (Ansong *et al.,* 2011). The relationship in the short-run was negative (Ansong *et al.,* 2011).

Based on the above discussion, it is clear that the current body of knowledge in terms of financial innovation and economic growth has potential for expansion. Adjasi (2015) argues that while research has been conducted in the area of transformation and development, creating and supporting innovative methods for providing finance to the masses, there is still an extensive amount of work to be done in the research area, particularly in terms of the overall effect on Africa's growth and development (Adjasi, 2015). Chikezie et al., (2017) contributes to this argument, highlighting the large amount of theoretical research being conducted on the topic of innovation and growth, with little empirical work being done. Therefore, gaps in the

current body of knowledge regarding the topic contribute to the debate and also some doubt between academics, around the reliability of primary survey data collected, and the weakness of previous studies; thus exemplifying the need for empirical evidence to support or disprove the existing literature (Chikezie *et al.,* 2017). Levine (2000) adds to this argument, stating that the existing literature provides evidence of the link between financial innovation and economic growth. However, the empirical evidence is not conclusive as to the extent that financial innovation contributes to growth.

Agoba et al., (2017) recommends that further empirical research is required to test the effect of financial development on both financial innovation and financial inclusion, as well as the effect of financial innovation on growth. Finally, while the "dark" side of financial innovation has been explored in developed countries, the potential negative effects of financial inclusion on financial stability in developing countries is relatively unknown in terms of empirical research, particularly with regard to the sensitivity of this relationship. Therefore, Agoba et al., (2017) recommends further research into the intermediating role of financial depth on the effect of financial inclusion on financial stability.

Beck et al., (2015) is self-proclaimed as being the first to conduct a study into the relationship between financial innovation, on the one hand and bank growth, fragility and economic growth on the other. However, the paper, based on thirty-two countries, only included one country from Africa, South Africa. While there are a number of studies focusing on the effects of financial innovation on the growth in Africa, the studies focuses on individual countries, namely Kenya, Nigeria and Ghana by Mwinzi (2014), Chikezie et al., (2017), Idun and Aboagye (2014) respectively. The study by Bara et al., (2016b) being the only study to date, covering the topic across a group of countries in Africa, namely the SADC regional block. Further research is required to establish the relationship across the African continent, as well as developing countries in general. This will also contribute to the research required, as indicated by Agoba et al., (2017), into the effect of financial innovation on financial growth, across varying levels of financial development, due to the varying states of financial systems and development across the African continent (Agoba *et al.,* 2017).

In studies that have already been conducted, and future studies on the topic, the measure used for financial innovation and financial inclusion needs to be refined and constant. With the definition and measure for financial innovation and financial inclusion varying across country's regulators statistics, this limits the potential for accurate comparability across studies. An

example of this is the basic measure for financial access as discussed by Barr (2004). He argues that while the measure used across countries may be the same, accounts per thousand adults, the way individual countries measure this in their data collection varies. Some countries might include accounts open, but rarely used; while others might exclude them. In other countries, an individual might have multiple accounts, and be reported as such, while others might consider additional accounts to be sub-accounts and thus not report them (Barr, 2004). Additional measures for financial innovation could also be included in future research studies, to test the relationship between economic growth and various financial innovations.

Multiple methods have also been used to establish the relationship between financial innovation and economic growth. Adu et al., (2013) and Idun & Aboagye (2014), used bound testing autoregressive distribute lag (ARDL) co-integration to find long-run growth effects of financial development in Ghana and short- and long-run relationships between financial innovation and economic growth respectively. Bara et al., (2016b), also utilised a ARDL model, but estimate the model using pooled mean group and dynamic, fixed effects (Bara et al., 2016). To test for a long-run relationship in their series to determine whether financial innovation resulted in growth in Nigeria (Chikezie *et al.,* 2017) utilised the Least Square (Gauss-Newton and the Levenberg-Marquardt steps) based on vector autoregressive (VAR) systems, to estimate their system model the Johansen co-integration test was used.

Taking into consideration the varied methods used to test the relationship between financial innovation and growth, as well as the availability of suitable data, this study utilises the most appropriate estimation tools as described in the following chapter.

CHAPTER 3:

RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlines the research methods undertaken to meet the objectives of this study. Information on the variables used, the measurement of variables and data sources for the variables are given, as well as a justification for the inclusion of said variables. Following this the models chosen, and the relevant econometric tools used to estimate the models and analyse the data are introduced and explained.

3.2 Data and Sources

Various data sources have been utilised in the analysis. The data utilised for analysis was sourced from the World Bank World Development Indicators, as well as the International Monetary Fund's Financial Access Survey, for the period 1990 to 2016. Table 1 shows the countries included in the study sample, the region which they fall into on the African continent, as well as their income level classification.

Table 1: Analysis Countries, Region and Income Level Classification

Country	African Region[9]	Income Level[10]
Angola	Central	Lower middle income
Botswana	South	Upper middle income
Cote D'Ivoire	West	Lower middle income
Egypt	North	Lower middle income
Gabon	Central	Upper middle income
Ghana	West	Lower middle income
Kenya	East	Lower middle income
Lesotho	South	Lower middle income
Madagascar	East	Low income
Malawi	East	Low income
Mali	West	Upper middle income
Mauritius	East	Low income
Namibia	South	Upper middle income
Niger	West	Low income
Nigeria	West	Lower middle income
Rwanda	East	Low income
Senegal	West	Low income
Seychelles	East	Lower middle income
South Africa	South	High income
Swaziland	South	Lower middle income
Tanzania	East	Low income
Tunisia	North	Low income
Uganda	East	Upper middle income
Zambia	East	Lower middle income
Zimbabwe	East	Low income

[9] African Region classification is based on those of the United Nations Statistical Division and the World Bank

[10] Income Group classification as given by the World Development Indicators. The World Bank classification of economies is based on estimates of gross national income (GNI) per capita in 2010. Upper middle-income countries are those for which GNI per capita for the previous year is $4,086 to $12,615. Lower middle-income countries are those for which GNI per capita for the previous year is $1,036 to $4,086.

Countries indicated in Table 1, included in the sample were included for their potential contribution to the robustness of analysis of the sample. The following countries (Angola (Central), Botswana (South), Lesotho, Madagascar (East), Malawi (East), Mauritius (East), Mozambique (East), Namibia (South), Seychelles (East), South Africa (South), Swaziland (South), Tanzania (East), Zambia (East), Zimbabwe (East) were included to allow for comparison and for testing consistency when compared with previous studies conducted by Bara and Mudzingiri, (2016), Bara et al., (2016b) and Idun and Aboagye (2014), to test the relationship between financial innovation and economic growth.

Another factor for selecting countries for inclusion was the high levels of penetration of mobile money. Mobile money is seen as an integral part of financial innovation in Africa, with forty percent of the adult population utilising mobile money services, according to GSMA's 2015 State of the Industry Report on Mobile Money (Global System for Mobile Communications (GSMA), 2015). The countries that exhibited this quality were Gabon, Ghana, Kenya, Namibia, Tanzania, Uganda and Zimbabwe. Similarly, specifically in West Africa, Niger, Nigeria, Ghana, Cote D'Ivoire, Mali, Senegal were included due to the significant increases in transactions utilising financial innovations after the launch of Orange Money (Frydrych, 2017). Finally, Tunisia, Egypt and Gabon were included to allow for a spread of countries across all African regions, chosen as the three countries currently influenced by financial innovation in the North and Central African regions.

3.3 Model Specification

This study adopts an approach utilised by Bara, Mugano and Le Roux (2016), Idun and Aboagye, (2014) and Samargandi, Fidrmuc and Ghosh (2015) and extends the work on the relationship between financial innovation and growth by Laeven, Levine and Michalopoulos (2013), by investigating a similar relationship in African countries. Bara, Mugano and Le Roux (2016), Idun and Aboagye, (2014) and the Samargandi, Fidrmuc and Ghosh (2015) studies focused on the SADC region, Ghana and the middle income countries across the globe respectively, while Laeven, Levine and Michalopoulos (2013) utilised data from the United States of America.

This is done by utilising the extended Aghion, Howitt, and Mayer-Foulkes' (AHM) model, developed by Laeven, Levine, and Michalopoulos (2013), and more specifically, in the African region, according to Bara, Mugano, and Le Roux (2016). The model follows below:

$$g - g_1 = b_0 + b_1 F + b_2(y - y_1) + b_3 F(y - y_1) + b_4 X + \varepsilon$$

Where: $g - g_1$ is the average growth rate per capita income relative to growth

$(y - y_1)$ is the logarithm of per capita income relative to per capita income

F is financial development (measured as credit to the private sector as a share of GDP)

X is a set of control variables

ε is an error term

The model builds on the work of Schumpeter which showed entrepreneurs who earned profits by inventing better goods, regardless of the level of development (Bara et al., 2016). The initial model's shortfall was the exclusion of financial development or the role of the financial system. This limited the models finding's ability to assist in the development of policies, laws and regulations, which had the potential of having a significant impact on both technological and financial innovator's incentives towards further additional innovations, and thereby making contributions to economic growth (Michalopoulos *et al.*, 2009).

In contrast to the AHM model, the Laeven et al., (2013) model highlighted the integral role of financial innovation. Their model also incorporated financial development, showing financial development in previous periods, which contributed to future financial development. Therefore, by building on the AHM model, Laeven et al., (2013) produced the following cross-country panel regression (Bara et al., 2016):

$$g_{i,t} - g_{1i,t} = b_0 + b_1 F_{i,t} + b_2(y_{i,t} - y_{1i,t}) + b_3 F_{i,t}(y_{i,t} - y_{1i,t}) + b_4 X_{i,t} + b_5 f_{i,t} + b_6 f_{i,t}(y_{i,t} - y_{1i,t}) + \sigma_i + \mu_{i,t}$$

Where: subscript *t* represents the particular period, for each country *i*,

σ_i is the coefficient of the country specific effect

as well as control for a time-specific effect in each period

The extended model effectively assisted in making two integral arguments. Firstly, that technological and financial innovation is positively related and secondly, that economies would stagnate without the presence of innovation, and which emphasised the importance of both financial innovation and financial development in any period, as an outcome of previous financial innovations. Therefore, the key addition by Laeven, Levine, and Michalopoulos, the key dimension; relates to the model's prediction that financial innovation, or the rate of

financial system improvement has an impact on the speed at which an economy converges towards the world technology frontier.

Bara, Mugano and Le Roux, (2016a) made a further addition to the model, by including two additional variables to the model; namely the ratio of broad money to narrow money and mobile banking, to measure the recent innovations in the financial sector. Mobile banking was included, with mobile penetration utilised as a proxy. However, as indicated by Bara, Mugano and Le Roux, mobile penetration may not necessarily correlate with mobile banking rates in the relevant countries, particularly when considering the time frames, in relation to the introduction of mobiles and mobile banking respectively. Specifically, mobile technology was introduced to the African continent in the early 1990's, with mobile banking only introduced after 2011 (Bara et al., 2016).

Therefore, in this study, while mobile penetration will be included as a proxy for mobile banking, mobile banking will also be included, by the addition of the variables mobile accounts, mobile transactions and mobile agents, to assess the specific impact mobile banking has had on the economic growth in specific countries. In order to do this two models are specified.

The first regression model to be estimated in this study is:

Model 1:

$$\mathrm{GDPG}_{i,t} = GBCP_{i,t} + M2M1_{i,t} + ATM_{i,t} + GCF_{i,t} + GVEX_{i,t} + TRD_{i,t} + \varepsilon_{i,t}$$

Where GDPG represents economic growth, GBCP and M2M1 represents financial innovation specifically Growth in Total Credit by Banks to the Private Sector and the ratio of broad and narrow money; ATM represents financial innovation specifically Automated Teller Machines. Finally control variables are included, namely, *GCF*, *GVEX* and *TRD* representing Gross Capital Formation, Government Expenditure and Trade Openness, respectively. The subscripts *i* and *t* represent the relevant country and period respectively. Financial Development is not included in the model, due to the high levels of correlation with the ATM and GCF variables. In this study, additional focus will be given to the varying effects of financial innovation on growth across countries, with different levels of financial development utilising qualitative analysis, based on a financial development index for individual countries. The potential argument is that the level of financial development may impact the extent whereby financial innovation influences economic growth.

The remaining regression models to be estimated in this study will follow the first, with the inclusion of mobile accounts, mobile agents, mobile penetration and mobile transactions in four individual models, to assess the impact of the various elements of mobile banking on economic growth.

The remaining regression models to be estimated in this study therefore are:

Model 2:

$$\mathrm{GDPG}_{i,t} = GBCP_{i,t} + M2M1_{i,t} + ATM_{i,t} + GCF_{i,t} + GVEX_{i,t} + TRD_{i,t} + MACC_{i,t} + \varepsilon_{i,t}$$

Model 3:

$$\mathrm{GDPG}_{i,t} = GBCP_{i,t} + M2M1_{i,t} + ATM_{i,t} + GCF_{i,t} + GVEX_{i,t} + TRD_{i,t} + MAGT_{i,t} + \varepsilon_{i,t}$$

Model 4:

$$\mathrm{GDPG}_{i,t} = GBCP_{i,t} + M2M1_{i,t} + ATM_{i,t} + GCF_{i,t} + GVEX_{i,t} + TRD_{i,t} + MPEN_{i,t} + \varepsilon_{i,t}$$

Model 5:

$$\mathrm{GDPG}_{i,t} = GBCP_{i,t} + M2M1_{i,t} + ATM_{i,t} + GCF_{i,t} + GVEX_{i,t} + TRD_{i,t} + MTRA_{i,t} + \varepsilon_{i,t}$$

where MACC, MAGT, MPEN and MTRA represent mobile accounts, mobile agents, mobile penetration and mobile transactions, respectively. The two models are separated due to the likelihood of high correlation between the aforementioned variables and the subsequent high collinearity, as well as the limited amount of data available for mobile variables, when compared with data in Model 1.

3.4 Definition and Measurement of Variables

The study utilised various measures as indicators of financial innovation, namely Growth in Bank Sector Credit to Private Sector (GBCP), following Michalopolous, Laeven, and Levine (2009, 2013) and Idun and Aboagye (2014); the ratio of Broad Money to Narrow Money (M2|M1), following Ansong, Marfo-Yiadom and Ekow-Asmah (2011) and Bara et al., (2016b), Automatic Teller Machines (ATM) and finally Mobile Money Banking. Mobile Money Banking is represented by Mobile Accounts, Mobile Agents, Mobile Penetration and Mobile Transactions. Control Variables include Gross Capital Formation (Bara et al., 2016), Government Expenditure (Bara et al., 2016) and Trade Openness (Bara et al., 2016), represented by Domestic credit to private sector, Gross Fixed Capital Formation, Government

Final Consumption Expenditure and the sum of Exports and Imports, respectively, all as a percentage of GDP. Finally, Economic Growth is measured using real GDP per capita growth.

Table 2: Variables Description and Source

Variable	Description	Definition	Source	Literature Source
Economic Growth				
GDPG	Economic Growth	Growth in gross domestic product divided by midyear population (2010 USD)	World Development Indicators	
Financial Innovation				
GBCP	Growth in bank credit to private sector	Domestic credit to private sector by banks (% of GDP)	Calculation using World Development Indicators figures	Michalopolous, Laeven, and Levine (2009, 2013), Idun and Aboagye (2014), Bara, Mugano and Le Roux (2016), Jianguo and Qamruzzaman (2017)
M2M1	Broad Money to Narrow Money	Broad Money divided by Narrow Money	Calculation using World Development Indicators figures	Ansong, Marfo-Yiadom and Ekow-Asmah (2011) , Bara, Mugano and Le Roux (2016), Jianguo and Qamruzzaman (2017)
ATM	Automated Teller Machines (ATMs)	Automated teller machines (per 100,000 adults)	World Development Indicators	(Chikezie *et al.*, 2017)
Mobile Financial Innovation				
MACC	Mobile Accounts	Mobile money accounts (active per 1,000 adults)	IMF Financial Access Survey	-
MAGT	Mobile Agents	Mobile money agent outlets (active per 100,000 adults)	IMF Financial Access Survey	-
MPEN	Mobile Penetration	Mobile cellular subscriptions (per 100 people)	World Development Indicators	Bara, Mugano and Le Roux (2016)
MTRA	Mobile Transactions	Mobile money transactions (number per 1,000 adults)	IMF Financial Access Survey	-
Control Variables				
GVEX	Government Expenditure	Government Final Consumption Expenditure (% of GDP)	World Development Indicators	Bara, Mugano and Le Roux (2016), Samargandi et al., 2015, Adu, Marbuah and Mensah (2013), Jianguo and Qamruzzaman (2017)
GCF	Capital Stock	Gross Fixed Capital Formation (% of GDP)	World Development Indicators	Bara, Mugano and Le Roux (2016), Samargandi et al., (2015), Adu, Marbuah and Mensah (2013), Jianguo and Qamruzzaman (2017)
TRD	Trade Openness	Exports + Imports (% of GDP)	World Development Indicators	Bara, Mugano and Le Roux (2016), Adu, Marbuah and Mensah (2013), Samargandi et al., (2015), Jianguo and Qamruzzaman (2017)

Growth in Bank Sector Credit to Private Sector (GBCP) is used, as improvements in financial services are measured easily, as they do not include credit given by government or public institutions (Michalopoulos *et al.*, 2009), and also shows the promotion of financial innovation in the financial sector (Amore, Schneider, & Aldokas, 2013). The measure is likely to effectively gauge improvements in financial services, as it does not include credit to government or public enterprises (Michalopoulos *et al.*, 2009). Increase in bank credit across states, also has the ability to promote financial innovation in non-financial sectors (Bara et al., 2016). The relationship with economic growth is expected to be positive.

The ratio of Broad Money to Narrow Money (M2|M1) has an effect on the demand for real cash balance, income and interest elasticities of demand (Arrau, Gregorio, Reinhart, & Wickham, 1995). The introduction of additional money substitutes as a result of financial innovation, and therefore impacts the ratio by substituting M2 more than M1 (Mannah-Blankson & Belnye, 2004). The relationship between economic growth and M2M1 is unconfirmed.

Mobile Money, Mobile Banking and ATMs are financial innovations which have facilitated increased access to finance, as well as improving financial depth across African countries. By providing additional methods of access, these inventions have provided a positive effect on growth. By providing alternative banking options and outlets, they have facilitated an increase in consumption by addressing specific household and business needs, and therefore theoretically promoting economic activity (Chikezie *et al.*, 2017).

ATM's are computerized telecommunications devices that provide clients of a financial institution with access to financial transactions in a public place (World Development Indicators (2017). The transactions done, utilising ATM's, have a positive effect on growth, through its promotion of economic activity. Although the innovation is approximately fifty years old, it is relatively new to some areas in African countries. The invention, one of the first to bring together money, cash and technology, changed the manner in which payments are made, and through this, it changed the relationship between cash, credit, risk and convenience (Shepherd-Barron, 2017). ATM's, mobiles, solar powered and satelite have been linked more recently, in Africa specifically, and becomes a means of access to finance, which allows for transactions to take place at individuals' convenience (Idun & Aboagye, 2014), for example in refugee camps in Kenya and Somalia (Shepherd-Barron, 2017). We therefore expect the relationship between ATMs and the transactions done utilising them, to be positively correlated to economic growth.

Mobile Money and Banking serves as a "virtual bank" (Chikezie *et al.,* 2017) and increases financial access and depth, by providing an additional method for transactions to be completed. Mobiles are able to store value and currency in an account via the handset, and convert cash both inside and outside the store value account, and transfer the value between accounts (Donner & Tellez, 2008). The relationship between mobile banking and economic growth is expected to be positive.

Zandi, Singh, & Irving (2013) conducted a study to investigate whether a movement towards the usage of debit and credit cards, in the long-term, would have an impact on economic growth. Electronic card payments like debit and credit cards, increase efficiency as well as consumption in the economy. In addition to this, they increase the levels of transarency and accountability, while also decreasing fraud levels, all contributions to the fundamentals of economic growth (Zandi *et al.,* 2013). The final variables, the control variables include Government Expenditure, Capital Formation and Trade Openness.

The rationale for utilising these variables as indicated above, culminates into the rationale for the study, namely that financial innovation, through its contribution towards access to finance and credit, improves the efficiency of the financial sector and thereby increases economic activity and growth (Bara et al., 2016; Idun & Aboagye, 2014); particularly through the total factor productivity channel. The effects of financial innovation measures on growth, where they were tested individually, as well as collectively, to determine their unique effects on growth (Chikezie *et al.,* 2017).

3.5 Estimation Approach

A panel analysis was conducted to test the relationship between economic growth and financial innovation. The models used to determine the effect of mobile money banking on economic growth utilised fixed and random effect panel data analysis. To ensure that the correct model was chosen, the F-test for fixed effects was also to be used to determine whether a fixed effect model is appropriate for the data being analysed. Similarly, the Breusch-Pagan Lagrange Multiplier (LM) test for random effect model will also be conducted.

Finally, the Hausman test will be used to compare the results of the abovementioned tests to compare the potential fixed and random effects models, should both effects be significant.

The same dataset is then utilised to estimate the abovementioned relationship within the individual countries included in the panel. These estimations are used to assess the (Bara *et al.,*

2016a) theory that SADC countries, and in this case African countries in general, vary in terms of financial development and therefore the possibility exists that results may vary when estimates are run for individual countries.

Models one and four's regression models are therefore estimated, utilising the ordinary least squares method. This analysis is limited to these two models, due to the limited mobile accounts, mobile agents and mobile transactions data, proving to be insufficient for this estimation method. The results are analysed quantitatively, as well as qualitatively, utilising the individual country's level of financial development indices.

CHAPTER 4: DISCUSSION OF FINDINGS

4.1 Introduction

This chapter includes the analysis of data and a discussion of the findings. Data is analysed to assess the relationship between financial innovation in a panel of African countries, on an individual country level, and within two sub-samples of higher and lower financially development countries. The results will be split into four sections namely, Descriptive Statistics, Correlation Analysis and finally Regression Results for the panel, country level and financial development results respectively.

4.2 Descriptive Statistics

The descriptive statistics relating to the effect financial innovations and mobile financial innovations have on economic growth on the African continent are shown in Table 3.

Table 3: Descriptive Statistics

	Mean	Med.	Max.	Min.	SD	Skew	JB	N
GDPG	1,694	1,764	36,981	-47,806	4,852	-1,212	16308,430	675
GBCP	0,466	0,468	56,933	-36,061	4,304	1,795	100956,900	630
M2M1	2,405	1,793	22,787	1,146	1,629	5,623	62589,520	403
ATM	14,395	6,969	69,281	0,040	16,173	1,570	137,129	265
GCF	21,396	21,259	60,018	0,000	7,611	0,897	332,839	562
GVEX	16,415	15,045	50,000	2,047	6,666	1,651	713,488	625
TRADE	73,178	70,813	178,994	11,087	30,675	0,387	19,188	587
MOBPEN	40,656	15,713	185,822	0,000	49,041	1,020	112,764	647
MOBACC	233,236	121,339	1182,847	0,000	287,480	1,460	2,804	64
MOBAGT	119,662	51,023	687,819	0,000	163,773	1,762	39,880	54
MOBTRA	6362,637	1472,998	41649,830	2,370	9792,918	1,836	55,064	65

Notes: *GDPG = Gross Domestic Product Growth (Economic Growth), GBCP = Growth in Bank Credit to private sector, M2M2 = ratio of Broad Money to Narrow Money, ATM = Automated Teller Machines; GCF = Capital Stock; GVEX = Government Expenditure; TRADE = Trade Openness; MOBPEN = Mobile Money Penetration; MOBACC = Mobile Money Account; MOBAGT = Mobile Money Agents MOBTRA = Mobile Money Transaction, Source; Author's estimate from research data*

The variables in Table 3 are highly volatile across African countries, with standard deviations ranging from 1,629 to 49,041 and from 1,716 to 9792,918 for M2M1 and mobile penetration respectively in the tables. Trade, Automated Teller Machines and the mobile variables have the highest levels of volatility. The range in GDP growth, the dependant variable, across the countries is also noteworthy, ranging from a minimum of -47,806 to a maximum of 36,981.

The high variation in the variables may be attributed to the economic and financial system diversity of African economies. The overall growth levels on the continent are largely dependent on the economic growth seen in countries with overpowering weight on the average growth, in regions for example, the Nigerian or South African economy (African Development Bank Group, 2017). This potentially masks the noteworthy variation in growth between regions and countries, due to the varying structure of African countries (African Development Bank Group, 2017).

Similarly, the large variation in mobile penetration can be attributed to the diverse nature of mobile expansion in countries across the continent. While mobile penetration on the continent has excelled in many countries, the expansion in some countries has largely outpaced the growth in others (Ondiege, 2010). Barriers including, but not limited to, low income levels, literacy, lack of infrastructure and excessive tax charges, present stumbling blocks to increased mobile phone acquisition and usage (Ondiege, 2010).

4.3 Correlation Analysis

In examining the independent assumption of the linear regression models described in Chapter 3, the correlation coefficients of pairs of the regression variables are estimated and presented in Table 4. The financial innovations M2M1 and ATM have a negative correlation with growth, while the remaining financial innovation variable GBCP has a positive, but weak relationship with growth. All the mobile financial innovation variables included in the study, namely mobile accounts, mobile agents, mobile transactions and mobile penetration, also have a positive, albeit weak relationships with GDPG.

The mobile variables (MOBPEN, MOBAGT and MOBTRA) also show high levels of correlation with each other, particularly mobile accounts with mobile transactions and mobile agents, as well as mobile agents with mobile transactions. The mobile financial innovation variables have therefore been estimated in individual models, to allow the maximum number of variables to be estimated. No single variable or form of financial innovation can be deemed

appropriate and complete for measuring the phenomenon's significance on the economy (Ajide, 2013). Therefore, all financial innovation variables were retained in the study to account for the potential varied effect individual financial innovations can have on an economy and economic growth (Ajide, 2013; Jianguo & Qamruzzaman, 2017).

Table 4: Correlation Analysis

	GDPG	GBCP	M2M1	ATM	GCF	GVEX	TRADE	MOBACC	MOBAGT	MOBTRA	MOBPEN
GDPG	1										
GBCP	0,040	1									
M2M1	-0,478	-0,004	1								
ATM	-0,243	-0,232	0,155	1							
GCF	0,011	0,116	0,354	-0,562	1						
GVEX	-0,194	-0,167	0,117	0,519	0,133	1					
TRADE	-0,129	0,025	0,277	-0,459	0,618	-0,274	1				
MOBACC	0,018	0,159	0,127	-0,301	0,281	-0,156	0,192	1			
MOBAGT	0,144	0,048	-0,154	-0,405	0,122	-0,241	0,025	0,743	1		
MOBTRA	0,143	0,092	-0,065	-0,336	0,108	-0,375	0,132	0,864	0,915	1	
MOBPEN	0,081	0,279	0,382	-0,468	0,309	-0,495	0,281	0,565	0,548	0,619	1

Notes: *GDP, GBCP = Growth in Bank Credit to private sector, M2M2 = Ratio of Broad Money to Narrow Money, ATM = Automated Teller Machines; GCF = Capital Stock; GVEX = Government Expenditure; TRADE = Trade Openness; MOBPEN =Mobile Money Penetration; MOBACC = Mobile Money Account; MOBAGT = Mobile Money Agents MOBTRA = Mobile Money Transaction, Source; Author's estimate from research data*

4.4 Regression Results

The results from the estimated regression equations from Models 1 to 5 are presented in Table 5. The estimations were separated into five separate models for two reasons. Models were separated to account for the high correlation between selected mobile variables, namely mobile accounts with mobile transactions and mobile agents, as well as mobile agents with mobile transactions (MOBACC, MOBAGT, MOBTRA, MOBPEN). Secondly, the lack of mobile financial innovation data due to mobile banking being introduced, from 2011 onwards in various countries, reduced the number of countries and period covered from Models 2 to 5. The sample for these mobile models has therefore been reduced and estimated individually.

All five models were estimated using the Fixed Effects Model and Random Effects Model, after which the appropriate estimation was determined, utilising the Hausman test. The diagnostics of the estimations are also presented in Table 5. The random effects model proved to be the most appropriate for the Mobile Accounts, Mobile Transactions and Mobile Penetration models, based on the results of the Hausman test. The Fixed Effects Model is most appropriate for the remaining Mobile Agents model and finally the Financial Innovation model for excluding any mobile variables.

The results from Model 1 (excluding mobile money indicators) indicates that Automated Teller Machines (ATMs) and Trade Openness (TRADE) are the only significant determinants of economic growth. The effect of ATMs was observed to be negative, while TRADE's effect is positive. This indicates that increases in ATMs in the sample countries resulted in a decline on economic growth, while trade openness was observed to be growth-enhancing. The financial innovation variables included in the model, Broad Money to Narrow Money (M2M1) and Growth in Bank Credit to Private Sector (GBCP), were all observed to have a negative effect on growth, like ATMs, however their effect on the dependant variable is not significant. Similarly, the remaining control variables Government Expenditure (GVEX) and Capital Formation (GCF) both have a negative relationship with growth and thus, are not significant.

GBCP retains a negative relationship with growth in Models 2 to 5, with the coefficient significant in Model 2 (Mobile Accounts). The negative effect indicates that increases in Mobile Accounts resulted in a decline in growth. The results contrasted with those of Ajide (2013), Jianguo and Qamruzzaman (2017), Laeven et al., (2013) and Michalopoulos et al., (2009), but in line with those of Idun & Aboagye (2014) when tested in the long-run; the long-run results of Bara et al., (2016b) in their model without mobile money; and the short-run results when mobile money is added to their model. The results are therefore in line with previous studies conducted in Africa as the Idun and Aboagye (2014) and Bara et al., (2016b) tested the relationships in Ghana and the SADC respectively. According to economic theory, the development of the banking sector should have a positive effect on economic growth and development, through the capital accumulation channel (Jianguo & Qamruzzaman, 2017). Several factors could be contributing to the negative effects seen in the African context.

According to the South African Reserve Bank (2014) the possibility exists that the credit provision to the private sector is low, due to it being crowded out by credit in the household sector, usually utilised for final consumption, and not for productive use. Bara et al., (2016b) also contributed to this argument, emphasizing that the negative effects seen could be attributed to non-performing loans on the continent, affecting the distribution and crowding-out of credit to the private sector. Idun and Aboagye (2014) added that the lack of distribution, together with the underdeveloped nature of credit contributed to this negative effect on growth.

Innovations in Africa are beginning to improve both the distribution and quality of credit provided; however it may be too early to see the positive effect this could have on growth. It

may be premature both practically, as well in terms of data availability, to test the relationship empirically. Should financial innovations continue to improve, the efficiency of banks, and financial institution role player's ability to mobilise savings and the ability to allocate required funds to productive and performing areas will improve (Idun & Aboagye, 2014). The significance of GBCP seen in the Mobile Accounts model, could be highlighting the potential effect banking shifting in this manner could have on growth.

Like GBCP, M2M1 is observed to have negative co-effects in Models 2 to 5. The variable was observed to be significant in Models 2, 3 and 5 at a significance level ranging between five percent and one percent. The results which are in line with those of Bara et al., (2016b), are however, inconsistent with the theoretical arguments of Petkovski and Kjosevski (2014), Shaw (1973) as explained by Bara et al., (2016b), and general economic theory, as explained by Jianguo and Qamruzzaman (2017). Bara et al. (2016b) elaborates on the Petkovski and Kjosevski (2014) theory, that savings deposits increase at a faster pace than transaction balances, as financial systems grow and help economic growth by boosting economic activity, through this financial deepening. According to the general economic theory, increases in money supply will increase combined production, at a reduced cost. The increase in money supply increases the option of credit in the country's economy, with a lower cost of capital (Jianguo & Qamruzzaman, 2017). Bara et al., (2016b) however, go further, stating that this may not be the case in the African context, due to increased inflation and imports, because of increased liquidity. Heightened inflation and imports is harmful to growth, due to the production limitations in many countries on the continent.

The effect of ATMs was observed to be negative and significant in Models 1, 3 (MOBAGT) and 4 (MOBPEN). However, the coefficients are observed to be positive and insignificant in Models 2 (MOBACC) and 5 (MOBTRA). The positive results in the Mobile Accounts and Mobile Transactions models are consistent with the results of Chikezie et al., (2017); however the results in these models are not significant. The negative results could be reflection of the argument made by Ajide (2013), where he states that ATMs could hamper growth and output. He argues that the increased use of ATMs and alternatives to cash, through its resultant intermediation efficiency and reduced transaction costs, could result in a subsequent reduction in the demand for cash for use in transactions, which might result in a decline in purchase of firms' goods and services (Ajide, 2013).

Table 5: Random Effects, Fixed Effects and Hausman Test Results

	Model 1		*Model 2*		*Model 3*		*Model 4*		*Model 5*	
	Financial Innovation (No Mobile)		*Mobile Accounts*		*Mobile Agents*		*Mobile Penetration*		*Mobile Transactions*	
	FEM	**REM**	**FEM**	**REM**	**FEM**	**REM**	**FEM**	**REM**	**FEM**	**REM**
	Coefficient	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**
C	3,986	1,691	34,890***	6,202**	34,178***	7,465***	4,323	2,589	31,926***	5,437
	(-3,171)	(-1,811)	(-10,389)	(-3,028)	(-7,965)	(-1,544)	(3,300)	(1,930)	(-10,717)	(-3,264)
GBCP	-0,026	-0,051	-0,327	-0,499**	-0,060	-0,258	-0,023	-0,046	-0,236	-0,375
	(-0,084)	(-0,082)	(-0,248)	(-0,234)	(-0,268)	(-0,206)	(0,084)	(0,082)	(-0,259)	(-0,239)
M2M1	-1,119	0,055	-5,934**	-1,345	-7,351***	-1,883***	-1,146	-0,008	-5,894**	-1,276
	(-0,815)	(-0,368)	(-2,211)	(-1,011)	(-2,141)	(-0,540)	(0,820)	(0,376)	(-2,290)	(-1,014)
ATM	-0,083**	-0,062	-0,273	0,050	-0,409*	0,020	-0,074*	-0,053*	-0,332	0,049
	(-0,039)	(-0,027)	(-0,251)	(-0,061)	(-0,212)	(-0,030)	(0,045)	(0,029)	(-0,260)	(-0,061)
GCF	-0,054	-0,014	0,096	0,312	0,113	0,254**	-0,047	-0,010	0,058	0,280
	(-0,069)	(-0,049)	(-0,257)	(-0,186)	(-0,228)	(-0,104)	(0,071)	(0,049)	(-0,254)	(-0,187)
GVEX	-0,081	0,044	-0,405	-0,312*	-0,056	-0,189**	-0,089	0,036	-0,191	-0,283*
	(-0,134)	(-0,068)	(-0,407)	(-0,159)	(-0,354)	(-0,077)	(0,136)	(0,069)	(-0,445)	(-0,164)
TRADE	0,071**	0,021	-0,117*	-0,031	-0,158***	-0,045**	0,069**	0,021	-0,105	-0,022
	(-0,029)	(-0,014)	(-0,062)	(-0,030)	(-0,056)	(-0,017)	(0,029)	(0,015)	(-0,064)	(-0,031)
MOBACC			**0,000**	**0,001**						
			(-0,002)	**(-0,002)**						
MOBAGT					**0,003**	**-0,001**				
					(-0,003)	**(-0,002)**				
MOBPEN							**-0,003**	**-0,010**		
							(0,009)	**(0,007)**		
MOBTRA									**0,000**	**0,000**
									(0,000)	**(0,000)**
R-squared	0,293	0,050	0,533	0,183	0,695	0,349	0,293	0,062	0,528	0,146
Adj R-squared	0,187	0,018	0,269	0,040	0,469	0,211	0,182	0,025	0,242	-0,011
F-statistic	2,760	1,557	2,017	1,279	3,080	2,530	2,641	1,684	1,845	0,930
Prob (F-statistic)	0,000	0,162	0,045	0,285	0,006	0,034	0,000	0,115	0,073	0,495
D-W Stat	1,574	1,394	2,415	1,890	2,611	1,696	1,576	1,414	2,389	1,890
Hausman χ^2	12,094		8,654		22,729		10,208		7,215	
Prob > χ^2	0,060		0,278		0,002		0,177		0,407	
Countries	19		11		11		19		11	
Observations	185		48		41		185		46	

*Notes: GDPG = Gross Domestic Product Growth (Economic Growth), GBCP = Growth in Bank Credit to private sector, M2M2 = Ratio of Broad Money to Narrow Money, ATM = Automated Teller Machines; GCF = Capital Stock; GVEX = Government Expenditure; TRADE = Trade Openness; MOBPEN = Mobile Money Penetration; MOBACC = Mobile Money Account; MOBAGT = Mobile Money Agents MOBTRA = Mobile Money Transaction, ***, ** and * denotes significance at 1%, 5% and 10% respectively. Source; Author's estimate from research data*

Most mobile variables included in the models have a positive relationship with growth, the only exception being Mobile Penetration. The mobile variables do not have a significant relationship with growth. However, all the proxies for mobile money (MOBACC, MOBAGT, MOBPEN and MOBTRA) all enter the regression models as insignificant. With the exception of Mobile Penetration, the results are consistent with those of Bara et al.,, (2016b), Chikezie et al., (2017) and Mwinzi (2014). Bara et al., (2016b) found a significant positive relationship between mobile banking and growth in the SADC, the Chikezie et al., (2017) study showed that mobile payments had an insignificant positive effect on growth in the Nigerian economy and Mwinzi (2014) found a significant positive relationship between mobile transactions and economic growth in Kenya. While the coefficients of mobile financial innovation are weak, due to limited data, the results support arguments that mobile financial innovation contributes positively to economic growth in Africa.

The effect of capital stock (GCF) is only observed to have a significant effect on economic growth in Model 3 (REM, MOBAGT). The positive coefficients also observed in Models 2 (MOBACC) and 5 (MOBTRA) were insignificant. This indicates that increases in capital stock has a growth-enhancing effect on the economy. The positive results are in line with the results of Bara et al., (2016b), and Jianguo and Qamruzzaman (2017).

The Government Expenditure (GVEX) results, however, have a significant negative relationship with growth in the Models 2 (MOBACC), 3 (MOBAGT) and 5 (MOBTRA) This observation indicates that increasing government expenditure has a detrimental effect on economic growth in the sampled countries. These results are also consistent with those seen by Bara et al., (2016b) in their mobile model. They substantiate the results arguing that Government Expenditure has the potential to have a negative effect on growth when expenditure is done in non-productive sectors of the economy or is financed through taxation or borrowing.

The final control variable, TRADE is significant and positive in the first model. The variable is also positive in the Mobile Transactions model. Contrasting these results is the negative and significant result in the Mobile Agents model. In both the Mobile Accounts and Mobile Transaction models, the relationship is negative but not significant. Trade is an integral component of growth in Africa, as the results in the Mobile Transactions and financial innovation model show. The negative results seen in the remaining models, may be attributed to the volatility in trade in many countries on the continent. The nature of trade on the continent

has changed, quadrupling over the last two decades, due to improvements in trade and regional integration. Despite the trend, intra-trade between countries on the continent, remains low despite improvements. The continent's exports are also dominated by China, and are therefore currently experiencing a decline in demand (African Development Bank Group, 2017).

According to the R-Squared values across the five models, the third model; the Mobile Agents model contains the strongest explanatory power for variation in growth, with more than two thirds of the variation in economic growth being explained by the model. This third model also contains the highest number of explanatory significant variables, with the fourth significant variable being the constant coefficient. The model's F-statistic is also the highest when comparing models and is significant at the ten percent significance level. The introduction of mobile variables to the first model also increases the R-Squared, when comparing between fixed effects models and random effects model respectively. This therefore advocates for the argument that mobile financial innovation has an essential role to play in the development and growth of economies in Africa.

Overall, the models estimated substantiate Ajide (2013) and Jianguo and Qamruzzaman (2017) arguments that different measurements of financial innovation yield different results. The models also show that measurements of financial innovation, will vary in their effect on financial development, depending on the model they are included in. The nature of the methodology used may also dilute the effects innovations are having on individual countries.

4.4.1 Country-level estimations

To account for country-level differences in the results, the models are estimated at country levels for a sample. The results for the individual country estimations are reflected in Tables 6 and 7. Table 6 represents results of estimations, utilising the same variables used in Model 1; specifically, the model excluding variables representing mobile financial innovation. Similarly, Table 7 represents the estimation results, using the same variables used in Model 4, using mobile penetration as a proxy for mobile banking representing mobile financial innovation.

In terms of model fit, represented by the R-Squared figure, the R-squared figures for the individual countries estimations excluding mobile variables are generally higher than the R-Squared figures seen in the panel estimations; except for the Mobile Agents model, which boasts the highest R-Squared figure amongst the panel models. In the second individual countries model, including mobile penetration, the R-Squared figures increase further with

Botswana, Cote D'Ivoire, Egypt, Gabon, Malawi and South Africa's figures, all exceeding the Mobile Agents R-Squared figure.

In the non-mobile individual countries estimation in Table 6, M2M1 and ATMs show negative relationships with growth in most of countries, while GBCP has an equal amount of countries having a positive and negative relationship, respectively. However, both GBCP and ATMs do not have a significant impact on growth in any of the countries tested. M2M1 has a significant positive relationship in Gabon and Malawi and a significant negative relationship in Cote D'Ivoire.

Table 6: Individual African Countries Results[11]

	GBCP	M2M1	ATM	GCF	GVEX	TRADE	R-squared	Adj R-squared	D-W Stat	Observations
Botswana	-0,681	2,256	-0,151	-0,545	-0,765	0,289*	0,507	0,096	2,333	12
	(0,775)	(3,002)	(0,458)	(0,717)	(0,823)	(0,143)				
Cote D'Ivoire	-0,776	-30,088*		1,183	1,091	0,195	0,737	0,605	1,996	13
	(0,699)	(15,349)		(0,422)	(0,651)	(0,177)				
Egypt	0,316	-1,300	-0,143	0,413	-0,078	0,074	0,732	0,509	1,802	12
	(90,273)	(3,273)	(0,468)	(0,472)	(1,339)	(0,135)				
Gabon	0,922	78,630*	1,383	1,319	-5,110	-1,123*	0,665	0,330	3,539	11
	(1,075)	(34,626)	(0,814)	(0,830)	(2,574)	(0,466)				
Ghana	-0,076	-2,116	-1,444	0,121	0,304	0,110	0,639	-0,262	3,200	8
	(1,530)	(8,710)	(1,143)	(0,704)	(0,888)	(0,293)				
Kenya	0,226	6,419	-0,364	0,230	-0,680	-0,047	0,045	-0,751	1,993	12
	(0,811)	(14,593)	(0,935)	(0,455)	(1,960)	(0,136)				
Lesotho	-0,278	0,201	0,073	-0,963	0,391	0,326	0,268	-0,951	1,853	9
	(0,951)	(4,486)	(0,860)	(3,200)	(1,664)	(0,583)				
Madagascar	0,194		-0,859	0,402	-0,959	0,003	0,488	0,196	1,837	12
	(1,496)		(1,400)	(0,240)	(0,682)	(0,052)				
Malawi	0,034	5,066*	0,262	1,086**	-1,058	-0,163**	0,685	0,423	1,448	12
	(0,405)	(2,543)	(0,802)	(0,441)	(0,684)	(0,062)				
Mali	-0,132	7,440		-0,288	-0,290	0,024	0,111	-0,334	1,526	13
	(0,341)	(7,779)		(0,487)	(0,625)	(0,084)				
Mauritius	-0,085	0,026		-0,058	0,176	0,035	0,115	-0,179	2,763	17
	(0,138)	(0,745)		(0,055)	(0,377)	(0,049)				
Namibia	-0,030	-2,440	-0,088	-0,408	0,359	0,348	0,365	-0,428	1,441	10
	(0,769)	(3,642)	(0,142)	(0,895)	(0,663)	(0,614)				
Rwanda	0,340	-1,675	-0,021	-0,174	-0,325	0,320	0,443	-0,021	2,289	12
	(0,546)	(12,473)	(0,407)	(0,771)	(0,793)	(0,374)				
Senegal	-0,391	-1,522		0,272	0,096	-0,082	0,223	-0,166	2,105	13
	(0,405)	(12,967)		(0,371)	(1,044)	(0,144)				
South Africa	0,046	-0,326	-0,193	-0,315	0,627	0,046	0,666	0,388	2,733	12
	(0,228)	(10,570)	(0,136)	(0,291)	(0,749)	(0,118)				
Swaziland	0,173	-0,970	-0,038	0,319	-0,590	0,110	0,323	-0,241	1,798	12
	(0,466)	(4,970)	(0,145)	(1,494)	(0,725)	(0,397)				
Tunisia	-0,389		-0,166	-0,062	0,264	0,019	0,368	0,115	2,101	15
	(0,262)		(0,178)	(0,161)	(0,505)	(0,056)				
Uganda	0,029	-4,959	-0,719	0,327	0,350	-0,005	0,650	0,359	2,510	12
	(0,290)	(6,073)	(1,340)	(0,222)	(0,484)	(0,140)				

Notes: *GDPG = Gross Domestic Product Growth (Economic Growth), GBCP = Growth in Bank Credit to private sector, M2M2 = Ratio of Broad Money to Narrow Money, ATM = Automated Teller Machines; GCF = Capital Stock; GVEX = Government Expenditure; TRADE = Trade Openness, ***, ** and * denotes significance at 1%, 5% and 10% respectively. Source; Author's estimate from research data*

[11] Angola, Niger, Nigeria, Seychelles, Tanzania, Zambia and Zimbabwe unable to run results due to insufficient observations or individual countries.

Table 7: Individual African Countries Results (Mobile Penetration)[12]

	GBCP	M2M1	ATM	GCF	GVEX	TRADE	MOBPEN	R-squared	Adj R-squared	D-W Stat	Observations
Botswana	-1,057*	-1,103	0,297	0,685	-2,440**	0,397**	-0,113**	0,812	0,587	3,456	12
	(90,540)	(2,346)	0,347	(0,649)	(0,809)	(0,104)	(0,040)				
Cote D'Ivoire	-0,709	-30,840*		1,062	1,250	0,190	0,013	0,740	0,554	1,968	13
	(0,777)	(16,506)		(0,606)	(0,877)	(0,189)	(0,045)				
Egypt	0,016	0,077	0,859*	0,367	-0,543	0,027	-0,082**	0,923	0,830	2,415	12
	(0,182)	(1,964)	0,396	(0,278)	(0,798)	(0,081)	(0,023)				
Gabon	1,911*	152,693**	-0,323	2,057	-8,040**	-2,252**	0,200**	0,860	0,651	2,724	11
	(0,882)	(40,073)	(0,931)	(0,676)	(2,234)	(0,584)	(0,084)				
Ghana	-0,406	-4,261	-0,632	0,212	0,389	0,170	-0,108	0,639	-0,262	3,200	8
	(2,354)	(13,856)	(3,149)	(1,003)	(1,238)	(0,446)	(0,365)				
Kenya	0,208	6,709	-0,273	0,214	-0,738	-0,039	-0,005	0,045	-1,100		
	(0,957)	(17,050)	(2,131)	(0,599)	(2,450)	(0,218)	(0,100)				
Lesotho	-0,205	-3,886	-0,969	-1,466	0,276	0,592	0,284	0,508	-0,969	1,814	9
	(0,958)	(6,123)	(1,365)	(3,256)	(1,676)	(0,645)	(0,288)				
Madagascar	-0,013		-9,030	0,530*	-1,075	-0,017	0,160	0,650	0,358	1,764	12
	(1,343)		(5,071)	(0,228)	(0,613)	(0,048)	(0,096)				
Malawi	-0,533	2,582	-3,286*	0,889*	-0,710	-0,161**	0,165*	0,848	0,665	2,225	12
	(0,394)	(2,214)	(1,651)	(0,347)	(0,542)	(0,047)	(0,071)				
Mali	-0,371	12,958		-0,481	-0,401	-0,037	0,060	0,182	-0,403	1,521	13
	(0,465)	(10,661)		(0,557)	(0,657)	(0,117)	(0,077)				
Mauritius	-0,098	-0,440		-0,077	0,572	0,001	0,078	0,211	-0,147	2,914	17
	(0,137)	(0,838)		(0,057)	(0,506)	(0,057)	(0,067)				
Namibia	-2,436	2,591	-0,584	-2,779	0,198	0,069	0,771	0,656	-0,033	1,924	10
	(1,649)	(4,429)	(0,335)	(1,674)	(0,573)	(0,551)	(0,485)				
Rwanda	0,373	-2,198	-0,049	-0,219	-0,275	0,324	0,007	0,446	-0,220	2,262	12
	(0,640)	(14,111)	(0,486)	(0,900)	(0,935)	(0,410)	(0,046)				
Senegal	-0,054	-6,417		-0,079	1,361	-0,103	-0,096	0,456	0,068	2,425	13
	(0,411)	(11,935)		(0,389)	(1,185)	(0,129)	(0,055)				
South Africa	0,014	5,926	-0,318	-0,302	0,323	-0,006	0,085	0,701	0,341	2,604	12
	(0,240)	(13,735)	(0,217)	(0,302)	(0,875)	(0,141)	(0,112)				
Swaziland	-0,146	-0,892	-0,441	-0,111	-0,946	0,007	0,292*	0,620	0,163	2,033	12
	(0,416)	(4,082)	(0,237)	(1,246)	(0,622)	(0,330)	(0,148)				
Tunisia	-0,473*		-0,523	-0,037	0,630	-0,049	0,057*	0,578	0,343	2,767	15
	(0,229)		(0,228)	(0,139)	(0,468)	(0,058)	(0,027)				
Uganda	0,022	-4,483	-1,158	0,317	0,353	-0,007	0,024	0,654	0,239	2,467	12
	(0,318)	(6,921)	(2,376)	(0,246)	(0,528)	(0,153)	(0,104)				

Notes: *GDPG = Gross Domestic Product Growth (Economic Growth), GBCP = Growth in Bank Credit to private sector, M2M2 = Ratio of Broad Money to Narrow Money, ATM = Automated Teller Machines; GCF = Capital Stock; GVEX = Government Expenditure; TRADE = Trade Openness, ***, ** and * denotes significance at 1%, 5% and 10% respectively. Source; Author's estimate from research data*

[12] Angola, Niger, Nigeria, Seychelles, Tanzania, Zambia and Zimbabwe unable to run results due to insufficient observations or individual countries.

When Mobile penetration is added to the estimation, GBCP, M2M1 and ATMs reflect negative relationships in most of countries tested. GBCP and M2M1 have a significant positive relationship in Gabon, while GBCP has a significant negative relationship in Botswana and M2M1 has a significant negative relationship in Cote D'Ivoire. Finally, ATMs have a significant positive relationship in Egypt and a significant negative relationship in Malawi.

In contrast to the panel results, where mobile penetration had a negative effect on growth, mobile penetration had a positive effect on growth in most of countries tested thirteen of the eighteen countries tested showed a positive relationship with Gabon, Malawi, Swaziland and Tunisia showing a significant positive relationship. When analysing these countries in terms of their financial development levels and their status in terms of enabling versus non-enabling regulation, the results vary. Half have enabling regulation (Malawi and Swaziland), while the remainder do not, and only Tunisia is ranked in the top one hundred countries, in terms of financial development.

Table 8: Analysis Countries, Region, Regulatory Environment and Financial Development Classification

Country	African Region[1]	Financial Development Level		Enabling Regulatory Environment	Non-Enabling Regulatory Environment
		Index	*Rank*		
South Africa	South	0.618	28		✔
Mauritius	East	0.389	53		✔
Seychelles	East	0.295	74	✔	
Egypt	North	0.28	77		✔
Namibia	South	0.269	81	✔	
Tunisia	North	0.239	93		✔
Botswana	South	0.219	100	✔	
Kenya	East	0.187	115	✔	
Cote D'Ivoire	West	0.168	119	✔	
Angola	Central	0.151	128	-	-
Swaziland	South	0.146	130	✔	
Nigeria	West	0.138	131		✔
Lesotho	South	0.136	133	✔	
Gabon	Central	0.133	134		✔
Zambia	East	0.128	137	✔	
Ghana	West	0.118	143	✔	
Senegal	West	0.113	147	✔	
Tanzania	East	0.103	153	✔	
Mali	West	0.099	158	✔	
Uganda	East	0.096	160	✔	
Malawi	East	0.093	162	✔	
Niger	West	0.089	163	✔	
Rwanda	East	0.08	170	✔	
Madagascar	East	0.079	171	✔	
Zimbabwe	East	-	-	✔	

Adapted from: GSMA (2017b) and Svirydzenka (2016); Overall index of Financial Development is an aggregate of indices summarising how developed financial institutions and financial markets are, in terms of their depth, access, and efficiency. One hundred and eighty-three countries were included in the study. Countries ranked according to Financial Development Level.

Interestingly, countries with non-enabling regulation are in the top one hundred countries, in terms of financial development, with Gabon being the only exception, ranking one hundred and thirty-four out of one hundred and eighty-three countries. Most countries without enabling regulation, who are ranked in the top one hundred, in terms of financial innovation, boast a positive relationship between MOBPEN and growth with Egypt being the only exception. Therefore, countries with high levels of financial development may not require enabling regulation mobile financial innovations to be encouraged, for those innovations to have a positive effect on growth.

However, higher financial development levels do not necessarily result in financial innovation proxies better illustrating its influence on growth. Only five out of eleven possible financial innovation proxy coefficients are positive where countries are ranked in the top one hundred in terms of financial development. This potential could contradict the theories set out by Bara et al., (2016b) who stated that the positive effects of financial innovation on growth are weakened by the underdevelopment of financial systems.

4.4.2 Financial Innovations and Economic Growth: The Role of Financial Development

The findings of the country level estimations show higher levels of financial development. This does not necessarily imply higher growth levels in financial innovation measures, particularly those which reflect financial development. To further investigate the impact financial development has on the relationship between financial innovation and economic growth, the models are estimated for sub-samples classified, based on their ranking in terms of financial development level.

The first sample group includes the twelve top ranking countries, as shown in Table 8. The Top ranking sample therefore includes South Africa, Mauritius, Seychelles, Egypt, Namibia, Tunisia, Botswana, Kenya, Cote D'Ivoire, Angola, Swaziland and Nigeria. The second sample group therefore includes the bottom ranked countries in Table 8 which include Lesotho, Gabon, Zambia, Ghana, Senegal, Tanzania, Mali, Uganda, Malawi, Niger, Rwanda and Madagascar. Tables 9 and 10 illustrate the estimations of the respective sample groups. The (FEM or REM) results presented in Tables 9 and 10 are based on the results of the Hausman specification test, except for the results in Models 2 and 3 in Table 9 and Model 3 in Table 10, where models could only be estimated using either FEM or REM.

Table 9: Financial Development Analysis (Top Ranked Countries)

	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*
	Financial Innovation (No Mobile)	*Mobile Accounts*	*Mobile Agents*	*Mobile Penetration*	*Mobile Transactions*
	REM	**FEM**	**FEM**	**FEM**	**FEM**
	Coefficient	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**
C	2,050	65,853***	58,396***	8,923*	54,248
	(2,755)	(20,741)	(18,103)	(5,402)	(14,896)
GBCP	-0,057	-0,130	0,240	-0,021	-0,018
	(0,097)	(0,329)	(0,338)	(0,101)	(0,238)
M2M1	-0,187	-8,575**	-10,472***	-1,070	-6,383***
	(0,437)	(3,193)	(3,203)	(1,052)	(2,323)
ATM	-0,047	-0,226	-0,416	-0,042	-0,173
	(0,037)	(0,319)	(0,259)	(0,056)	(0,167)
GCF	-0,041	0,156	0,181	-0,121	0,081
	(0,061)	(0,307)	(0,269)	(0,088)	(0,246)
GVEX	-0,029	-1,474**	-0,756	-0,402	-1,434***
	(0,142)	(0,699)	(0,614)	(0,266)	(0,512)
TRADE	0,052**	-0,145	-0,165	0,103***	-0,107
	(0,022)	(0,091)	(0,102)	(0,037)	(0,082)
MOBACC		**0,000**			
		(0,003)			
MOBAGT			**0,003**		
			(0,006)		
MOBPEN				**-0,007**	
				(0,013)	
MOBTRA					**0,000**
					(0,000)
R-squared	0,115	0,627	0,796	0,283	0,564
Adj R-squared	0,060	0,334	0,546	0,150	0,274
F-statistic	2,088	2,138	3,186	2,126	1,943
Prob (F-statistic)	0,062	0,091	0,046	0,014	0,082
D-W Stat	1,312	2,487	2,885	1,434	2,543
Hausman χ^2	9,655	-	-	13,995	23,822
Prob > χ^2	0,140	-	-	0,051	0,001
Countries	10	5	5	10	8
Observations	103	26	21	103	36

Notes: *GDPG = Gross Domestic Product Growth (Economic Growth), GBCP = Growth in Bank Credit to private sector, M2M2 = Ratio of Broad Money to Narrow Money, ATM = Automated Teller Machines; GCF = Capital Stock; GVEX = Government Expenditure; TRADE = Trade Openness, ***, ** and * denotes significance at 1%, 5% and 10% respectively. Source; Author's estimate from research data. Model 2 and 3 : Insufficient cross sections/ countries/ observations for Random Effects estimation*

Table 10: Financial Development Analysis (Bottom Ranked Countries)

	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*
	Financial Innovation (No Mobile)	*Mobile Accounts*	*Mobile Agents*	*Mobile Penetration*	*Mobile Transactions*
	REM	**REM**	**FEM**	**REM**	**FEM**
	Coefficient	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**
C	0,542	1,009	27,717	0,524	5,128
	(3,963)	(4,346)	(17,205)	(4,169)	(9,265)
GBCP	0,072	-0,774*	-0,459	0,076	-0,201
	(0,188)	(0,382)	(0,559)	(0,190)	(0,207)
M2M1	0,010	-0,092	-4,130	-0,216	-1,353
	(1,331)	(1,345)	(3,635)	(1,378)	(2,363)
ATM	-0,246*	-0,310	-0,972	-0,335	-1,532***
	(0,146)	(0,204)	(0,740)	(0,207)	(0,464)
GCF	0,188*	0,703***	-0,138	0,190*	-0,361
	(0,106)	(0,223)	(0,787)	(0,110)	(0,295)
GVEX	0,036	-0,356***	0,454	0,052	1,153***
	(0,083)	(0,120)	(0,854)	(0,091)	(0,373)
TRADE	-0,024	-0,069***	-0,213	-0,028	0,002
	(0,023)	(0,022)	(0,151)	(0,025)	(0,088)
MOBACC		**0,001**	**0,004**		
		(0,004)	**(0,006)**		
MOBAGT					
MOBPEN				**0,009**	
				(0,014)	
MOBTRA					**0,000**
					(0,000)
R-squared	0,078	0,474	0,710	0,084	0,759
Adj R-squared	0,005	0,258	0,173	-0,003	0,518
F-statistic	1,062	2,189	1,321	0,969	3,148
Prob (F-statistic)	0,393	0,089	0,368	0,460	0,020
D-W Stat	1,781	2,714	3,549	1,833	3,162
Hausman χ^2	5,819	7,101		5,390	40,009
Prob > χ^2	0,444	0,418		0,612	0,000
Countries	9	8	7	9	8
Observations	82	25	21	82	29

Notes: *GDPG = Gross Domestic Product Growth (Economic Growth), GBCP = Growth in Bank Credit to private sector, M2M2 = Ratio of Broad Money to Narrow Money, ATM = Automated Teller Machines; GCF = Capital Stock; GVEX = Government Expenditure; TRAD E= Trade Openness, ***, ** and * denotes significance at 1%, 5% and 10% respectively. Source; Author's estimate from research data. Model 3: Insufficient cross sections/ countries/ observations for Random Effects estimation*

When comparing the results to the full sample estimations in Table 5, the top ranked sample results are largely similar. The estimations have similar model fit trends in terms of R-squared figures. Specifically, the MOBAGT model maintains the highest fit with the remaining models also maintaining similar R-squared figures. The nature of the variable's relationship with growth has also largely remained the same. The first exception, where a measure's relationship has changed is GBCP in the MOBAGT model, changing from a negative to a positive relationship, second is TRADE in the MOBPEN model changing from positive to negative and finally, ATM in the MOBTRA model changing from positive to negative. In contrast to the results seen in the top ranked sample, estimating the models in a sample of countries with lower level of financial development results in significant shifts.

In terms of model fit, the MOBTRA now has the highest R-Squared figure with MOBAGT now having the second highest, making MOBTRA the most suited model. The nature of the relationships between variables included in the models and growth also sees multiple shifts, particularly in the model without mobile financial innovation (Model 1), the MOBPEN (Model 4) and MOBTRA (Model 5) models. The changes seen in Model 1 are largely positive – GBCP, M2M1, GCF and GVEX have a positive relationship in this model, as opposed to negative in the full sample estimations. The only negative shift is TRADE, from having a positive and significant relationship with growth to a negative one.

In the MOBPEN model, the GBCP, GCF and MOBPEN variables all have positive changes, particularly GCF, which is both positive and significant. The only negative change in the MOBPEN model is TRADE. The MOBTRA model sees three relationship changes, one being negative namely GCF, and two positive changes namely GVEX and TRADE. GVEX goes from having a negative relationship to a significant positive relationship, while TRADE now has a positive relationship with growth.

The lower ranked sample estimation therefore, has more relationship changes, the majority being positive. The results therefore show that financial innovation is likely to have a more positive effect on growth in countries where financial development is low. Furthermore, when comparing economies with high financial development with countries with lower financial development, MOBTRA is more important in the latter group.

Interestingly, the low-ranking sample group only contains one country with non-enabling regulation, Gabon, as opposed to the four countries included in the top-ranking sample where non-enabling regulation is present. These results may be in line with Allen and Ndikumana

(1998), Phakedi (2014) and Le Roux and Moyo (2015) who argue that financial development has a negative relationship with growth (Bara et al., 2016). The South African Reserve Bank (2014) also argues that a negative relationship exists, specifically in the SADC. However, in the SADC when analysed on a country level, the results vary, with half indicating a positive relationship and the other half negative (South African Reserve Bank, 2014).

This study's findings can be argued to be in line with studies by Samargandi, Fidrmuc, and Ghosh (2015) and Michalopoulos, Laeven and Levine (2009). Samargandi, Fidrmuc, and Ghosh (2015) focus on the relationship between financial development and economic growth specific to middle to low income countries. They find the relationship is u-shaped, with financial development having a negative impact on growth in the short-run, but not in the long-run. Their results contrast with those of (King & Levine, 1993) but are similar to those of (Loayza & Ranciere, 2006). They note that the relationship varies, according to a country's economic structure, institutional quality and financial markets.

The negative results between growth and financial development seen in this study, particularly in the top ranked countries are likely in line with those of Samargandi, Fidrmuc, and Ghosh (2015), as most of the countries are classified as having a middle to low income level, as indicated in Table 1, except for South Africa. As seen in these results, countries with higher levels of financial development have fewer variables having a positive relationship with growth.

This is in line with the results achieved by Michalopoulos, Laeven and Levine (2009), where they found financial innovation and not financial development improved the rate of economic growth, particularly in countries poorer than the economic leader (Michalopoulos et al., 2009). They argue that innovation is essential for ensuring growth that is sustainable. In addition, their model highlights the importance of policy and regulation, in ensuring that financial innovation is encouraged, to avoid decreasing economic growth. The results seen in the sample with low levels of financial development substantiate the findings of Michalopoulos et al., (2009) by showing that financial innovations have the ability to contribute positively to growth where financial development is low, when supported by enabling regulation, which encourages increased financial innovation in a country.

According to Levine (2005), as stated by Svirydzenka (2016), financial development includes improvements in functions provided by financial systems. This includes pooling savings, the ability to allocate capital to productive investing, the ability to monitor the productive

investments, the diversification of risk, and finally, the exchange of goods and services (Svirydzenka, 2016). Financial innovation also contributes to these functions, and therefore may be interchangeable with financial development. Financial innovation may therefore play an alternate role, in economies with low levels of financial development. It may also provide a level of financial development, which is currently included in formal classifications of financial development in economies, but not picked up in its current form as financial innovation.

This can further be linked to the Granger causality results found by Idun and Aboagye (2014) when testing the causality between financial innovation and financial development. Their study found bi-directional Granger causality between the two variables, further substantiating arguments for the positive effects financial innovation can have on financial development levels in a country.

The results also further substantiate the findings of the country level estimations, potentially negating the theories of Bara et al., (2016b) stating that the positive effects of financial innovation on growth is weakened by the underdevelopment of financial systems. With GBCP becoming positive in both Model 1 and 4, and M2M1 becoming positive in Model 1, when estimated in the lower ranked sample, the results show the positive effects of financial innovation can be seen, despite the financial development being weak.

The results in this chapter inform the conclusions drawn from this study and form the basis of recommendations for policy, regulation and areas for future research.

CHAPTER 5:

CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This final chapter presents a summary of the study, as well as the conclusions reached, based on the results found. Policy recommendations are made, based on these conclusions for the promotion of economic growth, as well as suggestions for future research.

5.2 Summary of Study and Conclusions

This study aimed to examine the relationship between financial innovation and economic growth. It did so by first establishing the relationship within a panel of African countries utilising panel estimation methods, fixed and random effects modelling. It went further to establish the same relationship in a sample of eighteen individual African countries, using Ordinary Least Squares estimations. Finally, an estimation was done to examine how the level of financial development impacted the relationship between financial innovation and economic growth. This estimation is done by estimating the relationship in two sub-sample groups, including countries which have high levels and low levels of financial development respectively.

This study examines how different measures of financial innovation affect economic growth. Measures include proxies Growth in bank credit to private sector (GBCP) and the ratio of Broad Money to Narrow Money (M2M1), as well as Automated Teller Machines (ATMs). The study places specific focus on mobile financial innovations including the proxy measure mobile penetration (MOBPEN), as well as measures of financial innovations namely, mobile accounts (MOBACC), mobile agents (MOBAGT) and mobile transactions (MOBTRA).

The empirical results indicate variations in the effect financial innoation has had on Africa as a whole, as opposed to the effects it has had on individual countries. The results seen in the panel estimations, representing Africa as a whole, contrast with those seen in the country level estimations.

In the panel of African countries, the majority of the variables which have a significant effect on the dependant variable economic growth, have a negative effect, therefore illlustrating that the financial innovation variables have a net negative effect on growth. However, when mobile

financial innovations are included in the models, namely mobile accounts, mobile agents, mobile transactions, and to an extent automated teller machines, the resultant effect on growth is positive. This is in contrast to the alternative proxy measurements used for financial innovation, M2M1 and GBCP, which are largely negative. While the mobile financial innovation's effects may not be significant in this study, the potential for these variables to have significance in the future is high, should robust data over an extensive time period become available.

The positive effect of mobile financial innovation is further highlighted when analysing country level results. When analysing at a country level, stronger relationships are seen between MOBPEN and growth, as well as overall better model fit across models estimated, in terms of the R-Squared values. This shift in results between the panel and country level results can be attributed to the varying nature of African economies and their financial development. The shift can also be attributed to the varying levels of mobile and mobile financial innovation expansion across African countries. The panel analysis therefore dilutes the successes of some countries and disguises the slow pace of expansion in others.

The positive results seen between mobile financial innovation and growth in both the panel and country level estimations, provides empirical evidence to substantiate the existing literature and theories, supporting financial innovation towards growth in African countries. It therefore also supports recommendations for increased emphasis on mobile financial innovation on the continent.

The negative results seen with measures, which previously have seen positive results in studies conducted in developed countries, illustrate the underdeveloped nature of financial systems in Africa. The consistently negative variables GBCP and M2M1 are examples. The negative results in these measures may not reflect the inability to financial innovation to contribute to economic growth but could instead be reflecting the effects of the lack of financial development, which should allow the innovation to affect growth in a manner that is visible through channels reflected in these measures.

Through analysis of countries with low levels of financial development, the argument that financial innovation has a positive effect on growth is further substantiated. Countries with lower levels of financial development, exhibit more positive relationships between financial innovation variables and growth, when compared to both countries with higher levels of development, as well as Africa as a whole. This study argues that financial innovation

contributes positively to the functions of a financial system, and therefore towards financial development, particularly in countries with low levels of financial development. The results seen, illustrate that financial innovation is able to contribute to financial development, as well as the growth of an economy, particularly when supported by regulation which encourages the increase in financial innovation. These results are of particular importance to African countries as the study has empirically shown that the positive effect of financial innovation on growth relationships is possible in poorer countries, and it substantiates previous work by Michalopoulos et al., (2009) and Samargandi et al., (2015).

Government Expenditure, also consistently negative in the panel models and negative in half the countries analysed, shows that governments in Africa generally are not spending in productive sectors or are funding the spending through taxation or borrowing.

The conclusions reached by this study form the basis of the recommendations made for policy and regulation, as well as avenues for future research.

5.3 Policy Recommendations

The results shown, and conclusions reached in this study, provide a platform on which policy recommendations can be made. Continued focus on financial innovation to improve access to finance, is imperative. Policy and regulatory focus should be on mobile banking innovations in particular (Bara et al., 2016; Napier, 2011). These innovations will ensure that all Africans, regardless of socioeconomic conditions or geographical spread will have access to financial services. By increasing the number of people with access to financial services, the depth of the financial system (Bara et al., 2016), efficient allocation of resources, financial intermediation is improved and efficient financial institutions can be achieved. All these improvements will contribute to improving currently underdeveloped financial systems on the continent, and greater economic growth.

The positive effects of financial innovation, particularly transaction-based innovations, are more pronounced in countries with low levels of financial development. Therefore, these countries should focus on promoting financial innovation in their economies. Methods to acknowledge and classify the effects that financial innovation has on the level of financial development in African countries should also be put in place. The contribution of existing financial innovations may not be accurately accounted for in current estimations or in the definitions and classifications themselves.

To counteract the consistent negative results seen for GBCP, regulatory authorities and banking institutions in Africa should endeavour to actively improve access to credit in the private sector; ensuring that credit is not solely channelled towards the household sector. This would enable productive sectors to finance investments and expansions, which in the long-term, will have the ability to contribute to future production and growth.

Policy and funding regarding government expenditure in African countries requires a shift in structure for it to have a positive effect on growth. Governments should focus on establishing which sectors are considered productive. Investing in these sectors will ultimately result in economic growth. The source of the funding for this expenditure should also be monitored. Funding alternatives should also be sourced, as alternatives to borrowing and taxation, for government expenditure to contribute to growth.

In terms of trade and trade openness, regionally, intra-trade should be encouraged further and more actively. The intra-trade growth rate from ten percent to eighteen percent, from 1995 to 2015 (South African Reserve Bank, 2014), can be vastly improved by encouraging regional integration. This will improve growth, both in the individual countries, regions, and potentially the continent as a whole. It will also reduce many country's dependence on non-African countries as export markets, particularly China, therefore protecting African economies from economic shocks and crises in developed countries.

It has been shown that regulation designed to facilitate and enable the progression of financial innovation, particularly mobile financial innovation has the ability to encourage competitors in the market and improve the effects of financial innovation on growth, while non-enabling regulation has the ability to stall the sector in its entirety (di Castri, 2015). The results in a small sample of individual countries is a testament to these previously empirically untested theories with countries with enabling regulation showing positive relationships between mobile financial innovation and growth. Regulation should encourage market activity and collaboration from the information and technology sector, for the provision of infrastructure, as well as both the banking and mobile sector. The regulation should therefore encourage cooperation and coordination across sectors. Together, these three sectors are able to provide innovative products and services catered to the needs of the unbanked; in a manner that is not detrimental to the safety and stability of a country's economy (Mlachila et al., 2013), when done within a legal framework. A regulatory system that allows for healthy competition (Jianguo & Qamruzzaman, 2017), should allow the private sector to innovate timeously as

demand trends shift within a given market. The majority of governments do not have the capacity to innovate in a swift and efficient manner. Therefore, governments should focus on creating an enabling environment which allows innovation to happen, without jeopardising the stability and safety of the financial system. The results also highlight the importance of an enabling regulatory environment, when a country does not have a developed financial system. This finding is of particular importance for African countries, as it may prove to be a simpler interim step towards improving financial innovation and therefore financial inclusion and economic growth. Adjusting a countries regulatory framework to be more enabling of financial innovation, could therefore serve as an interim step towards a more developed financial system.

Finally, policies and work needed for interventions like the above, to be successful, may require integration. Integration will be required, potentially in regional and economic blocks to ensure countries are able to realise the full potential of future innovation. Many individual countries are not large enough or do not have the necessary qualities required, to attract the funding required to successfully build the infrastructure and knowledge required to improve the growth of financial innovation (Bara et al., 2016).

5.4 Avenues for Future Research

This study is successful in adding to the body of research regarding financial innovation and economic growth on the African continent. By providing and analysing empirical data on the relationship between these two variables on the continent, individual counties, and finally within financial development sub-samples, this study has taken a step towards understanding financial innovation in Africa. As most of the countries in Africa are developing countries in the middle to low income tier, this study has also provided insight into the relationships in these respective areas. The individual country's results reflect the relationship at a more granular level. Together with the regulation classification, the study can analyse the impact this component of a country's structure has on the relationship between financial innovation and growth both in the individual country, as well as on Africa as a whole. Finally, with the analysis of countries with high and low levels of financial innovation, this study establishes that financial innovation has a greater positive impact in countries with lower levels of financial development. It also argues that financial innovation may contribute to financial development.

This therefore provides supporting evidence for future empirical research to be conducted, to test the relationship between innovation and growth, while considering the effects of both regulation and financial development in individual countries, in more detail. An additional element which could be added to a study of this nature in future, is an analysis of the varying impacts of regulation and financial development in emerging versus non-emerging economies. Additional research should also be conducted, to test whether, and to what extent, financial innovation contributes to financial development.

Previous studies have called for research to be conducted on the overall effect of innovation on Africa's growth and development (Adjasi, 2015). The current body of knowledge encompasses isolated studies focusing on this growth relationship in particular regions. For example (Bara et al., 2016) study conducted on the SADC development block, and Ajide's (2013) study covering the West African region. Studies have also been conducted testing the relationship in individual countries in Africa, namely Kenya, Nigeria and Ghana. A gap therefore still exists for the relationship to be analysed, in the remaining regions and countries. Understanding the nuances within countries and regions is also imperative to understanding how policy and regulation may impact across these countries and regions.

Finally, a limitation to potential future research which needs to be addressed is the availability of high quality, reliable, consistent and robust data, particularly data related to financial innovations on the continent. For example, mobile banking has existed and has been developing on the continent for several years, yet current data which is readily accessible is sparse. Access to existing, privately held data, as well as consistency in the way data is collected, would significantly improve the quality of future research. It will also allow more robust estimation methods to be used.

REFERENCES

Achugamonu, B. U. (2017). Agent Banking and Financial Inclusion: The Nigerian Experience. *Journal of Internet Banking and Commerce*, *22*(8).

Adjasi, C. K. (2015). On Financing Economic Activity and Development in Africa. In SU Language Centre (Ed.), *Inaugural lecture - University of Stellenbosch Business School*. SUN MeDIA.

Adu, G., Marbuah, G., & Mensah, J. T. (2013). Financial development and economic growth in Ghana: Does the measure of financial development matter? *Review of Development Finance*, *3*(4), 192–203. http://doi.org/10.1016/j.rdf.2013.11.001

African Development Bank Group. (2017). *African Economic Outlook 2017: Entrepreneurship and Industrialisation*. Paris: OECD Publishing. Retrieved from http://dx.doi.org/10.1787/aeo-2017-en Photo

Aghion, P., Howitt, P., & Mayer-Foulkes, D. (2005). The Effect of Financial Development on Convergence: Theory and Evidence. *Quarterly Journal of Economics*, *120*, 173–222.

Agoba, A. M., Bugri-anarfo, E., & Sare, Y. A. (2017). Financial Inclusion and Monetary Policy : A Review of Recent Studies. *Ghana Journal of Development Studies*, *14*(1), 231–254.

Ajide, F. M. (2013). Financial Innovation and Sustainable Development in Selected Countries in West Africa, (1934), 85–112.

Aker, J., & Mbiti, I. (2010). Mobile Phones and Economic Development in Africa. *Journal of Economic Perspectives*, *24*(3). http://doi.org/10.1257/jep.24.3.207

Allen, F. (2012). Trends in Financial Innovation and Their Welfare Impact: an Overview. *European Financial Management*, *18*(4), 493–514.

Allen, F., Otchere, I., & Senbet, L. W. (2011). African financial systems: A review. *Review of Development Finance*, *1*(2), 79–113. http://doi.org/10.1016/j.rdf.2011.03.003

Amirehsani, K. (2014). *Mobile money in Africa moves beyond M-Pesa*. Retrieved from http://globalriskinsights.com/2014/12/mobile-money-africa-move-beyond-m-pesa/

Amore, M., Schneider, C., & Aldokas, A. (2013). Credit Supply and Corporate Innovation. *Journal of Financial Economics*, *109*(3), 835–855.

Ansong, A., Marfo-Yiadom, E., & Ekow-Asmah, E. (2011). The effect of financial innovations on financial savings: evidence from an economy in transition. *Journal of African Business*, *12*(1), 93–113.

Arcand, J., Berkes, E., & Panizza, U. (2012). *Too much finance?* (No. 161). Retrieved from

https://www.imf.org/external/pubs/ft/wp/2012/wp12161.pdf

Arnaboldi, F., & Rossignoli, B. (2013). *Financial Innovation in Banking*. Retrieved from http://convegni.unicatt.it/ meetings_Arnaboldi_Rossignoli.pdf

Arrau, P., Gregorio, J. De, Reinhart, C. M., & Wickham, P. (1995). The Demand for Money in Developing Countries: Assessing the Role of Financial Innovation. *Journal of Development Economics*, *46*(2), 317–340.

Bara, A., & Mudzingiri, C. (2016). Financial innovation and economic growth : Evidence from Zimbabwe. *Investment Management and Financial Innovations*, *13*(2).

Bara, A., Mugano, G., & Roux, P. Le. (2016). Financial innovation and economic growth in the SADC. *African Journal of Science, Technology, Innovation and Development*, *8*(5–6), 483–495. Retrieved from https://www.imf.org/external/np/seminars/ eng/2014/lic/pdf/Moyo.pdf.

Barr, M. S. (2004). *Banking the Poor*. *Yale Journal on Regulation* (Vol. 21).

Beck, T., Chen, T., Lin, C., & Song, F. M. (2016). Financial innovation: The bright and the dark sides. *Journal of Banking and Finance*, *72*, 25–51. http://doi.org/10.1016/j.jbankfin.2016.06.012

Beck, T., Demiguc-Kunt, A., & Levine, R. (2006). Bank concentration, competition and crises: First results. *Journal of Money, Credit and Banking*, 1581–1603.

Beck, T., Senbet, L., & Simbanegavi, W. (2015). Financial Inclusion and Innovation in Africa: An Overview. *Journal of African Economies*, *24*(AERC Supplement 1), i3–i11. http://doi.org/10.1093/jae/eju031

Beddoes, Z. M. (2010). Financial Innovation Boosts Economic Growth. *The Economist*. Retrieved from http://www.economist.com/debate/days/view/471

Bilyk, V. (2006). *Financial Innovations and the Demand for Money in Ukraine*. Retrieved from http://www.kse.org.ua/uploads/file/library/ 2006/klymenko.pdf

Chibba, M. (2009). Financial inclusion, poverty reduction and the millennium development goals. *European Journal of Development Research*, *21*(2), 213–230.

Chikezie, K. A., Chijindu, E. H., & Okafor, I. . (2017). Does Financial Innovation Drive Growth ? Empirical Analysis of the Nigerian Case. *British Journal of Economics, Management & Trade*, *16*(3), 1–10. http://doi.org/10.9734/BJEMT/2017/30809

D'Cunha, S. D. (2017). Fintech Is The New Oil In The Middle East And North Africa. Retrieved December 15, 2017, from https://www.forbes.com/sites/suparnadutt/2017/12/11/fintech-in-mena-at-tipping-point-as-regulators-and-governments-start-taking-it-seriously/#6b91a7422316

Demirguc-Kunt, A., Klapper, L., Singer, D., & Van Oudheusden, P. (2015). The Global Findex Database 2014: Measuring Financial Inclusion around the World, (April). http://doi.org/10.1596/1813-9450-7255

di Castri, S. (2015). Is regulation holding back financial inclusion? A look at the evidence. Retrieved from https://www.gsma.com/mobilefordevelopment/programme/mobile-money/is-regulation- holding-back-financial-inclusion-a-look-at-the-evidence%0ALast

Ductor, L., & Grechyna, D. (2015). Financial development , real sector , and economic growth. *International Review of Economics and Finance*, *37*, 393–405. http://doi.org/10.1016/j.iref.2015.01.001

Dynan, K. ., Elmendorf, D. ., & Sichel, D. . (2006). Can financial innovation help to explain the reduced volatility of economic activity? *Journal of Monetary Economics*, *53*(1), 123–150.

European Investment Bank. (2016). *Banking in sub-Saharan Africa: Recent Trends and Digital Financial Inclusion*.

Fin24. (2016, July 26). SA Reserve Bank to focus on payment innovation. *Fin24*. Cape Town.

Frydrych, J. (2017). *Mobile money in West Africa : A closer look at the data*. Retrieved from https://www.gsma.com/mobilefordevelopment/programme/mobile-money/mobile-money-in-west-africa-a-closer-look-at-the-data

Global System for Mobile Communications (GSMA). (2015). *State of the Industry Report 2015: Mobile Money*. London, United Kingdom: Global System for Mobile Communications (GSMA).

Global System for Mobile Communications (GSMA). (2016). *The State of Mobile Money in Sub-Saharan Africa*. London, United Kingdom.

Global System for Mobile Communications (GSMA). (2017a). *State of the Industry Report on Mobile Money - Decade Edition 2006 - 2016 - Executive Summary*. London, United Kingdom: Global System for Mobile Communications (GSMA).

Global System for Mobile Communications (GSMA). (2017b). *State of the Industry Report on Mobile Money Decade Edition: 2006 - 2016*. London, United Kingdom: Global System for Mobile Communications (GSMA).

Goldsmith, R. W. (1969). *Financial structure and development*. New Haven: Yale University Press.

Gurley, J. G., & Shaw, E. S. (1995). Financial aspects of economic development. *The American Economic Review*, *45*(4), 515–538.

Hao, J., & Hunter, W. . (1997). A test of the impact of financial innovation on economic growth. *Managerial Finance*, *23*(11), 64–78.

Henderson, B. J., & Pearson, N. D. (2011). The dark side of financial innovation: a case study of the pricing of a retail financial product. *Journal of Financial Economics*, *100*(2), 227–247.

Idun, A. A.-A., & Aboagye, A. Q. Q. (2014). Bank competition, financial innovations and economic growth in Ghana. *African Journal of Economic and Management Studies*, *5*(1), 30–51. http://doi.org/10.1108/AJEMS-09-2012-0057

Institute of Development Studies. (2010). *Case Studies of Financial Innovation in Africa*.

Jianguo, W., & Qamruzzaman, M. (2017). Financial innovation and economic growth in Bangladesh. http://doi.org/10.1186/s40854-017-0070-0

King, R., & Levine, R. (1993). Finance and Growth Schumpter Might Be Right. *The Quarterly Journal of Economics*, *108*(3), 717–737. http://doi.org/10.2307/2118406

Klapper, L., & Singer, D. (2015). The Role of Informal Financial Services in Africa. *Journal of African Economies*, *24*(1), 12–31. http://doi.org/10.1093/jae/eju027

Laeven, L., Levine, R., & Michalopoulos, S. (2013). Financial Innovation and Endogenous Growth, (13005).

Lamikanra, B. (2015). How the finance sector can drive Africa's economic growth.

Levine, R. (1997). Financial development and economic growth: Views and Agenda. *Journal of Economic Literature*, *35*(2), 688–726. http://doi.org/10.1126/science.151.3712.867-a

Levine, R., Loayza, N., & Beck, T. (2000). Financial Intermediation and Growth: Causality and Causes. *Journal of Monetary Economics*, *66*, 31–77.

Levine, R., & Renelt, D. (1992). A Sensitivity Analysis of Cross-Country Growth Regressions. *American Economic Review*, *82*(4), 942–63.

Lewis, M. ., & Mizen, P. . (2000). *Monetary economics*. Oxford, UK: Oxford University Press.

Llewellyn, D. T. (2009). Financial innovation and a new economics of banking: Lessons from the financial crisis. Challenges for Monetary Policy-Makers in Emerging Markets.

Loayza, N., & Ranciere, R. (2006). Financial Development, Financial Fragility, and Growth. *Journal of Money, Credit, and Banking*, *38*(4), 1051–1076.

Lucas, R. E. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, *22*(1), 3–42.

Lumpkin, S. (2010). Regulatory Issues Related to Financial Innovation. *OECD Journal: Financial Market Trends 2009*, *2*, 1–31.

Maimbo, S., Saranga, T., & Strychacz, N. (2010). POVERTY REDUCTION AND ECONOMIC MANAGEMENT Facilitating Cross-Border Mobile Banking in Southern Africa, 1–5.

Mannah-Blankson, T., & Belnye, F. (2004). *Financial innovation and the demand for money in Ghana* (No. WP/BOG-2004/08). Accra.

Mauri, A. (1983). Research Center on International Cooperation of the University of Bergamo Giordano Dell-Amore Foundation THE POTENTIAL FOR SAVINGS AND FINANCIAL INNOVATION IN AFRICA / LE POTENTIEL D â€™ EPARGNE ET D â€™ INNOVATION FINANCIERE EN AFRIQUE Author (s): Arnaldo. *Savings and Development, 7*(4). Retrieved from http://www.jstor.org/stable/25829861

McKinnon, R. I. (1973). *Money and capital in economic development*. Washington: Brookings Institution Press.

Merton, R. C. (1992). Financial Innovation and Economic Performance. *Journal of Applied Corporate Finance*, *4*(4), 12–22.

Michalopoulos, S., Laeven, L., & Levine, R. (2009). *Financial Innovation and Endogenous Growth* (No. 15356).

Miller, M. . (1992). Financial innovation: achievement and prospects. In J. Chew (Ed.), *Corporate Finance:Where Theory Meets Finance* (pp. 385–410). New York, NY: McGraw-Hill.

Mishra, P. . (2007). Financial Innovation and Economic Growth -A Theoretical Approach, (1973). http://doi.org/https://dx.doi.org/10.2139/ssrn.1262658

Mlachila, M., Park, S. G., & Yabara, M. (2013). *Banking in Sub-Saharan Africa: the Macroeconomic Context*. *Banking in sub-Saharan Africa: Challenges and Opportunities*.

Mochiko, T. (2015, February 26). Mobile Money in Africa: Move towards Partnerships. *The Financial Mail*. Retrieved from http://www.financialmail.co.za/features/2015/02/26/mobile- money-in-africa-move-towards-partnerships.

Munyegera, G. K., & Matsumoto, T. (2017). ICT for financial access : Mobile money and the financial behavior of rural households in Uganda, 1–22. http://doi.org/10.1111/rode.12327

Mwinzi, D. M. (2014). The Effect of Financial Innovation on Economic Growth in Kenya By a Research Project Submitted in Partial Fulfilment of the Requirements of Degree of the Master of Business Administration , School of Business , University of Nairobi October

2014, (October).

Napier, M. (2010). *Real Money, New Frontiers - Case Studies Of Financial Innovation In Africa*. (M. Napier, Ed.). Cape Town: Juta and Company Ltd.

Napier, M. (2011). *Including Africa – Beyond Microfinance*. *Csfi* (Vol. 98). London: Centre for the Study of Financial Innovation (CSFI).

Ndirangu, L., & Nyamongo, E. M. (2015). Financial Innovations and Their Implications for Monetary Policy in Kenya. *Journal of African Economies*, *24*(1), 46–71. http://doi.org/10.1093/jae/eju029

Ondiege, P. (2010). Mobile banking in Africa: Taking the bank to the people. *Africa Economic Brief*, *1*(8), 1–15.

Petkovski, M., & Kjosevski, J. (2014). Does Banking Sector Development Promote Economic Growth? An Empirical Analysis for Selected Countries in Central and South Eastern Europe. *Economic Research – Ekonomska Istraživanja*, *27*(55–66). http://doi.org/doi:10.1080/1331677X.2014. 947107

Rajan, R. G., & Zingales, L. (1998). Financial dependence and growth. *The American Economic Review*, *88*(3), 559–586.

Ramsamy, P. (2014). 1 . Remittances from South Africa to SADC including effective practices . 2 . Financial inclusion in Southern Africa, (March).

Robinson, J. (1952). *The generalization of the general theory. In The rate of interest and other essays*. London: Macmillan.

Rousseau, P. L., & Wachtel, P. (2011). What is happening to the impact of financial deepening on economic growth? *Economic Inquiry*, *49*(1), 276–288.

Samargandi, N., Fidrmuc, J., & Ghosh, S. (2015). Is the Relationship Between Financial Development and Economic Growth Monotonic ? Evidence from a Sample of Middle-Income Countries. *WORLD DEVELOPMENT*, *68*, 66–81. http://doi.org/10.1016/j.worlddev.2014.11.010

Schumpeter, J. . (1911). *The Theory of Economic Development*. Cambridge, MA: Harvard University Press.

Schumpeter, J. A., & Opie, R. (1934). *The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle*. Cambridge, Mass: Harvard University Press.

Scylla, R. (1982). Monetary Innovation in American. *Journal of Economic History*, *42*(1), 21–30.

Shaw, E. S. (1973). *Financial deepening in economic development*. New York: Oxford

University Press.

Shepherd-Barron, J. (2017). Meet the true star of financial innovation — the humble ATM, 7–11.

Simpasa, A., Odour, J., Moyo, J., & Nandwa, B. (2014). *Financial Sector Reforms , Competition and Banking System Stability in Sub-Saharan Africa. Macroeconomic Challenges Facing Low-Income Countries*. Paper presented at the joint RES-SPR Conference on "Macroeconomic Challenges Facing Low-Income Countries" in Washington, DC, USA, January 30–31.

South African Reserve Bank. (2014). *Financial Sector Development and Economic Growth in SADC*. Pretoria, South Africa. Retrieved from https://www.sadcbankers.org/Lists/News and Publications/Attachments/197/Financial Sector Development (Final Aug 2014).pdf

Statistics Department - International Monetary Fund. (2016). *Financial Access Survey 2016*. Washington, DC.

Svirydzenka, K. (2016). *Introducing a New Broad-based Index of Financial Development* (No. WP/16/5).

Thompson, B. S. (2017). Can Financial Technology Innovate Bene fi t Distribution in Payments for Ecosystem Services and REDD + ? *Ecological Economics*, *139*, 150–157. http://doi.org/10.1016/j.ecolecon.2017.04.008

Tufano, P. (2003). Financial Innovation. In G. Constantinidis, M. Harris, & R. Stulz (Eds.), *Handbook of the Economics of Finance (Volume 1a: Corporate Finance)* (Vol. 1, pp. 307–336). Elsevier Masson SAS. http://doi.org/10.1016/S1574-0102(03)01010-0

Utterback, J. M., & Afuah, A. N. (1998). The Dynamic "Diamond": A Technological Innovation Perspective. *Economics of Innovation and Technology*, *6*(2–3), 183–200.

World Economic Forum. (2012). *Insight Report: The Financial Development Report 2012*. *World Economic Forum*. Geneva, Switzerland, New York, USA. Retrieved from http://www3.weforum.org/docs/WEF_FinancialDevelopmentReport_2012.pdf

World Economic Forum. (2016). *Regional Agenda World Economic Forum on Africa: Connecting Africa's Resources through Digital Transformation*.

Yeboah, O. A. (2016). About 70 % of " Susu " collectors operating illegally. *Htebftonline*. Ghana. Retrieved from http://thebftonline.com/business/economy/17449/about-70-of-susu-collectors-operating-illegally.html

Zandi, M., Singh, V., & Irving, J. (2013). The Impact of Inequality on Economic Growth on Economic Growth, 1–16.

APPENDICES

Appendix A: Financial Development Analysis (Top Ranked Countries)

	Model 1		*Model 2*		*Model 3*		*Model 4*		*Model 5*	
	Financial Innovation (No Mobile)		*Mobile Accounts*		*Mobile Agents*		*Mobile Penetration*		*Mobile Transactions*	
	FEM	**REM**	**FEM**	**REM**	**FEM**	**REM**	**FEM**	**REM**	**FEM**	**REM**
	Coefficient	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**
C	7,695	2,050	65,853***		58,396***		8,923*	1,967	54,248	2,217
	(4,852)	(2,755)	(20,741)		(18,103)		(5,402)	(1,911)	(14,896)	(2,437)
GBCP	-0,025	-0,057	-0,130		0,240		-0,021	-0,063	-0,018	-0,173
	(0,100)	(0,097)	(0,329)		(0,338)		(0,101)	(0,096)	(0,238)	(0,224)
M2M1	-0,981	-0,187	-8,575**		-10,472***		-1,070	-0,125	-6,383***	0,096
	(1,034)	(0,437)	(3,193)		(3,203)		(1,052)	(0,290)	(2,323)	(0,535)
ATM	-0,058	-0,047	-0,226		-0,416		-0,042	-0,049*	-0,173	-0,064
	(0,048)	(0,037)	(0,319)		(0,259)		(0,056)	(0,028)	(0,167)	(0,043)
GCF	-0,129	-0,041	0,156		0,181		-0,121	-0,013	0,081	0,004
	(0,086)	(0,061)	(0,307)		(0,269)		(0,088)	(0,045)	(0,246)	(0,065)
GVEX	-0,361	-0,029	-1,474**		-0,756		-0,402	0,095	-1,434***	0,157
	(0,253)	(0,142)	(0,699)		(0,614)		(0,266)	(0,104)	(0,512)	(0,113)
TRADE	0,107***	0,052**	-0,145		-0,165		0,103***	0,031**	-0,107	-0,010
	(0,036)	(0,022)	(0,091)		(0,102)		(0,037)	(0,015)	(0,082)	(0,022)
MOBACC			**0,000**							
			(0,003)							
MOBAGT					**0,003**					
					(0,006)					
MOBPEN							**-0,007**	**-0,016****		
							(0,013)	**(0,008)**		
MOBTRA									**0,000**	0,000
									(0,000)	(0,000)
R-squared	0,281	0,115	0,627		0,796		0,283		0,564	0,070
Adj R-squared	0,157	0,060	0,334		0,546		0,150		0,274	-0,162
F-statistic	2,268	2,088	2,138		3,186		2,126		1,943	0,302
Prob (F-statistic)	0,009	0,062	0,091		0,046		0,014		0,082	0,947
D-W Stat	1,426	1,312	2,487		2,885		1,434		2,543	1,625
Hausman χ^2	9,655		-		-		13,995		23,822	
Prob > χ^2	0,140		-		-		0,051		0,001	
Countries	10		5		5		10		8	
Observations	103		26		21		103		36	

*Notes: GDPG = Gross Domestic Product Growth (Economic Growth), GBCP = Growth in Bank Credit to private sector, M2M2 = Ratio of Broad Money to Narrow Money, ATM = Automated Teller Machines; GCF = Capital Stock; GVEX = Government Expenditure; TRADE = Trade Openness, ***, ** and * denotes significance at 1%, 5% and 10% respectively. Source; Author's estimate from research data. Model 3 and 4: Insufficient cross sections/ countries/ observations for Random Effects estimation*

Appendix B: Financial Development Analysis (Bottom Ranked Countries)

	Model 1		*Model 2*		*Model 3*		*Model 4*		*Model 5*	
	Financial Innovation (No Mobile)		*Mobile Accounts*		*Mobile Agents*		*Mobile Penetration*		*Mobile Transactions*	
	FEM	**REM**	**FEM**	**REM**	**FEM**	**REM**	**FEM**	**REM**	**FEM**	**REM**
	Coefficient	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**
C	3,793	0,542	12,464	1,009	27,717		3,811	0,524	5,128	4,442
	(5,760)	(3,963)	(14,274)	(4,346)	(17,205)		(5,796)	(4,169)	(9,265)	(2,596)
GBCP	0,041	0,072	-0,967**	-0,774*	-0,459		0,028	0,076	-0,201	0,109
	(0,193)	(0,188)	(0,422)	(0,382)	(0,559)		(0,196)	(0,190)	(0,207)	(0,189)
M2M1	-1,515	0,010	-0,959	-0,092	-4,130		-1,500	-0,216	-1,353	-0,271
	(1,611)	(1,331)	(3,059)	(1,345)	(3,635)		(1,621)	(1,378)	(2,363)	(1,077)
ATM	-0,201	-0,246*	-0,624	-0,310	-0,972		-0,111	-0,335	-1,532***	-0,209
	(0,161)	(0,146)	(0,536)	(0,204)	(0,740)		(0,264)	(0,207)	(0,464)	(0,192)
GCF	0,267**	0,188*	-0,113	0,703***	-0,138		0,286**	0,190*	-0,361	-0,023
	(0,132)	(0,106)	(0,524)	(0,223)	(0,787)		(0,140)	(0,110)	(0,295)	(0,064)
GVEX	0,093	0,036	0,236	-0,356***	0,454		0,085	0,052	1,153***	0,036
	(0,134)	(0,083)	(0,595)	(0,120)	(0,854)		(0,137)	(0,091)	(0,373)	(0,065)
TRADE	-0,075	-0,024	-0,039	-0,069***	-0,213		-0,077	-0,028	0,002	-0,005
	(0,057)	(0,023)	(0,140)	(0,022)	(0,151)		(0,057)	(0,025)	(0,088)	(0,011)
MOBACC			**-0,007**	**0,001**	**0,004**					
			(0,006)	**(0,004)**	**(0,006)**					
MOBAGT										
MOBPEN							**-0,008**	**0,009**		
							(0,019)	**(0,014)**		
MOBTRA									**0,000**	**0,000**
									(0,000)	**(0,000)**
R-squared	0,443	0,078	0,692	0,474	0,710		0,445	0,084	0,759	0,070
Adj R-squared	0,327	0,005	0,262	0,258	0,173		0,319	-0,003	0,518	-0,240
F-statistic	3,810	1,062	1,608	2,189	1,321		3,526	0,969	3,148	0,226
Prob (F-statistic)	0,000	0,393	0,227	0,089	0,368		0,000	0,460	0,020	0,975
D-W Stat	1,978	1,781	3,595	2,714	3,549		1,971	1,833	3,162	1,395
Hausman χ^2	5,819		7,101				5,390		40,009	
Prob > χ^2	0,444		0,418				0,612		0,000	
Countries	9		8		7		9		8	
Observations	82		25		21		82		29	

Notes: *GDPG = Gross Domestic Product Growth (Economic Growth), GBCP = Growth in Bank Credit to private sector, M2M2 = ratio of Broad Money to Narrow Money, ATM = Automated Teller Machines; GCF = Capital Stock; GVEX = Government Expenditure; TRADE = Trade Openness, ***, ** and * denotes significance at 1%, 5% and 10% respectively. Source; Author's estimate from research data. Model 3: Insufficient cross sections/ countries/ observations for Random Effects estimation*